(EEAP) LIGHTING SURVEY STUDY

AT THE

CORPUS CHRISTI ARMY DEPOT

CORPUS CHRISTI, TEXAS

FINAL REPORT

US Army Corps
of Engineers
Fort Worth Division

DTIC QUALITY INSPECTED 2

CONDUCTED BY

HUITT-ZOLLARS, INC.

CONSULTING ENGINEERS

FORT WORTH, TEXAS

4/5/95

(EEAP) Lighting Survey Study
at the
Corpus Christi Army Depot
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FINAL REPORT
April 5, 1995

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I. EXECUTIVE SUMMARY

A. Introduction

This energy conservation study was performed by Huitt-Zollars Inc, for the U.S. Army Engineer District (USAED), Fort Worth, under contract number DACAC63-94-D-0015. The study was conducted at Corpus Christi Army Depot (CCAD) in Corpus Christi, Texas, between October 3, 1994 and April 5, 1995. The site survey and data collection was performed by C.A. Pieper, P.E. and Tom Luckett, Lighting Designer.

The purpose of the study was to perform a limited site survey of specific buildings at the facility, identify specific Energy Conservation Opportunities (ECOs) that exist, and then evaluate these ECOs for technical and economic feasibility. These ECOs were limited to building interior lighting and it's effects on the heating, ventilating and air conditioning (HVAC) systems.

This survey was conducted with the assistance of many individuals at the facility, both CCAD and Navy staff. Special thanks are extended to all of them, including the following individuals:

Adan Pena, Energy Coordinator, CCAD

Albert Martinez, Electrical Engineering Technician, CCAD

Scott Hinte, Mechanical Engineer, CCAD

Roy Arispe, Maintenance Supervisor, CCAD

Park Lee, Mechanical Engineer, Naval Air Station

Any questions concerning this report should be directed to the Project Manager, C.A. Pieper, P.E., at Huitt-Zollars Inc., 512 Main Street, Suite 1500, Fort Worth, Texas 76102. Phone 817-335-3000.

B. Buildings Studied

The buildings included in this study and their total building areas are listed below:

Building 8	- 1,214,055 sqft
Hangar 43	- 106,039 sqft
Hangar 44	- 95,072 sqft
Hangar 45	- 95,072 sqft
Hangar 47	- 106,039 sqft

In building 8, only the offices which had pendent mounted fluorescent lights in the administrative areas, and high output fluorescent lights in the production areas, as well as the large and small hangar areas were included in this study. Although certain lighting ECOs existed in other areas of the building, the scope of work limited the analysis to the areas mentioned previously. See page F-12 for details. Maps of the buildings and areas studied are shown on pages C-10 through C-17.

C. Present Energy Consumption

Base Year Energy Consumption: The total metered electrical and steam consumptions for 12 consecutive months, prior to this study, were obtained from the facility and are referred to as the 'base year'. These data are shown on page 10 and are summarized as follows:

Electrical	52.930 MWH
Steam	115.744 MLBS

Lighting Energy Consumption: The present annual lighting energy consumption (HVAC not included) for the building areas studied was calculated on page B-2 as follows:

Lighting Energy	2,598,077 KWH
	4.9% of base year total

D. Energy Conservation Opportunity (ECO) Analysis

ECOs Rejected: After reviewing the data collected at the facility and considering all of the practical limitations involved, certain potential ECOs were rejected prior to performing calculations. These ECOs are summarized below with their reasons for rejection.

1. *Remove Lamps or Fixtures:* This ECO was rejected because no areas were found that had excessive amounts of lighting, or where painting walls alone would improve light levels enough to reduce the quantity of lamps or fixtures. Lowering the fixtures in some of the production areas was possible, but the expense would not be justifiable because of the age and inefficiency of the old direct/indirect fixtures. It would make more sense to just install newer, more efficient fixtures at a lower height. See ECOs Recommended.

2. *Install Additional Switches in Large Areas, Turn Lights Off:* Most of the production areas and all of the office areas were evenly occupied during working hours, and the addition of extra switches for groups of lights in a large area would not allow lights to be turned off. Those areas that had irregular or intermittent occupancy were considered for adding occupancy sensors to turn off lights. See ECOs Recommended.

3. *Replace Incandescent Fixtures, Reduce Lighting Wattage:* Very little if any incandescent lighting is present in CCAD buildings, and the areas studied were directed specifically at the areas with fluorescent or high bay HID fixtures.

4. *Install Fluorescent Reflectors in Existing Fixtures:* This ECO requires installing the polished silver reflectors into 4 lamp fluorescent fixtures and then removing 2 lamps and a ballast. While this cuts the fixtures energy consumption in half, it also drops the lumen output from the fixture by at least 1/3, based on IES tests. Therefore, an area must be overlighted by at least 33% in order to maintain acceptable light levels. Very few areas were found that could meet this criteria.

5. *Replace Exit Signs With Low Wattage Signs:* There are many different types of exist signs at CCAD, and many are not illuminated. Because there appears to be no stringent requirement for illuminated exit signs at the facility, any uniform replacement of the existing signs with low wattage illuminated signs would likely increase the lighting energy consumption. However, all new exit sign installations should be standardized to

use only low wattage LED or fluorescent types, rather than the incandescent type.

6. *Install Compact Fluorescent Lamps in Incandescent Fixtures:* These new compact fluorescent lamps can be easily replaced at a later time with inefficient incandescent lamps, therefore eliminating the benefit of any lamp retrofit project. Since the longevity of this energy conservation retrofit cannot be guaranteed, this potential ECO has been rejected.

ECOs Recommended: Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility and are recommended for implementation. Complete documentation of all calculations as well as information required for implementation is included in Appendix D. These recommended ECOs are summarized below in order of descending Savings to Investment Ratio (SIR).

ECO D-1: Provide Motion Sensor Controls For Production Storage Areas of Building 8.

Electrical Energy Savings	76,789	KWH/yr
Steam Energy Penalty	0	klb/yr
Total Energy Savings	262.08	MMBTU/yr
Total Cost Savings	5,779	$/yr
Total Investment	4,358	$
Simple Payback	0.7	yrs
SIR	20.44	

ECO D-2: Provide Daylighting Controls For Large Hangar in Building 8

Electrical Energy Savings	63,936	KWH/yr
Steam Energy Penalty	0	klb/yr
Total Energy Savings	218.2	MMBTU/yr
Total Cost Savings	3,879	$/yr
Total Investment	10,393	$
Simple Payback	2.7	yrs
SIR	5.81	

ECO D-3: Provide Daylighting Controls For Repair Hangars 43, 44, 45 and 47.

Electrical Energy Savings	226,759	KWH/yr
Steam Energy Penalty	0	klb/yr
Total Energy Savings	773.3	MMBTU/yr
Total Cost Savings	13,757	$/yr
Total Investment	41,573	$
Simple Payback	3.0	yrs
SIR	5.16	

ECO D-5: Replace Fluorescent Lighting In Production Areas of Building 8

Electrical Energy Savings	686,616	KWH/yr
Steam Energy Penalty	830.7	klb/yr
Total Energy Savings	1,597.5	MMBTU/yr
Total Cost Savings	54,131	$/yr
Total Investment	477,286	$
Simple Payback	8.8	yrs
SIR	1.74	

ECO D-4: Replace Pendent Mounted Fluorescent Lighting In Administrative Areas

Electrical Energy Savings	48,052	KWH/yr
Steam Energy Penalty	53.8	klb/yr
Total Energy Savings	115.7	MMBTU/yr
Total Cost Savings	3,147	$/yr
Total Investment	29,424	$
Simple Payback	9.3	yrs
SIR	1.66	

ECOs Not Recommended: Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility but are not recommended for implementation. Complete documentation of all calculations are included in Appendix E. These non-recommended ECOs are summarized below in order of order of descending SIR.

ECO E-1: Install Electronic Ballasts and Energy Savings Lamps In Fluorescent Fixtures

Electrical Energy Savings	409,466	KWH/yr
Steam Energy Penalty	478.9	klb/yr
Total Energy Savings	1397.5	MMBTU/yr
Total Cost Savings	17,651	$/yr
Total Investment	407,015	$
Simple Payback	23.0	yrs
SIR	0.69	

Because of the extremely long payback period, it is recommended to simply replace them with more efficient fixtures. (see ECOs D-4 and D-5)

ECIP Projects Developed. The facility decided not to submit any projects for ECIP funding. All projects will be submitted for funding as Non-ECIP projects.

Non-ECIP Projects Developed. The following projects will be submitted for funding as Non-ECIP projects:

Project 1. Lighting Controls Installation (ECOs D-1, 2, 3)

Electrical Energy Savings	367,484	KWH/yr
Steam Energy Penalty	0	klb/yr
Total Energy Savings	1,254	MMBTU/yr
Total Cost Savings	23,415	$/yr
Total Investment	56,324	$
Simple Payback	2.4	yrs
SIR	6.46	

Project 2. Fluorescent Lighting Upgrade in Office Areas (ECO D-4)

Electrical Energy Savings	48,052	KWH/yr
Steam Energy Penalty	53.8	klb/yr
Total Energy Savings	115.7	MMBTU/yr
Total Cost Savings	3,147	$/yr
Total Investment	29,424	$
Simple Payback	9.3	yrs
SIR	1.66	

Project 3. Fluorescent Lighting Replacement With HID in Production Areas (ECO-5)

Electrical Energy Savings	686,616	KWH/yr
Steam Energy Penalty	830.7	klb/yr
Total Energy Savings	1,597.5	MMBTU/yr
Total Cost Savings	54,131	$/yr
Total Investment	477,286	$
Simple Payback	8.8	yrs
SIR	1.74	

Recommended Maintenance & Operations Practices: Although CCAD is generally doing a good job of maintaining lighting energy efficiency, the following maintenance and operations (M&O) practices are recommended to help conserve lighting energy at the CCAD.

1. The Energy Coordinator should work together with the CCAD Director of Public Works to develop a Standard Specification for all future lighting repair and renovation projects. All facility lighting designers, as well as the lighting maintenance contractors, should be required to follow this specification. The energy coordinator should review all new lighting designs to check for compliance with the specifications. This will help to eliminate the inadvertent use of inefficient lighting systems at the facility.

2. Facility lighting designers should obtain and use published design lighting levels for all lighting renovation projects or new installations. This will help to eliminate overlighting.

3. The installation of new incandescent lighting should be prohibited. More efficient sources should be used in all cases.

4. The energy coordinator should direct considerable energy conservation efforts towards the production processes using electrical and steam energy, as these are the largest areas of potential savings. See page 10, *Utility Data*, for more details.

5. The energy coordinator should attend training seminars for building energy managers, whenever possible, such as those listed in Appendix G.

E. Energy And Cost Savings

Total Potential Energy and Cost Savings. The calculated energy and cost savings from the implementation of all 3 projects is as follows:

Electrical Energy Savings	1,102,152	KWH/yr
Steam Energy Penalty	884.5	klb/yr
Total Energy Savings	2,967	MMBTU/yr
Total Cost Savings	80,693	$/yr
Total Investment	563,034	$
Simple Payback	6.9	yrs

Energy Use and Costs Before and After. Based on the base year electrical and steam energy consumptions and costs shown on page 10, and the calculated total potential savings above, the CCAD energy and usage and costs before and after implementation of the 3 Non-ECIP projects is as follows:

	Before	After
Electrical	52.930 MWH	51.827 MWH
Steam	115.7 MLBS	116.6 MLBS
Total Cost	4,422,942 $	4,342,249 $

Percentage Saved. Based on the base year electrical and steam energy consumptions and costs, the percentage of savings from the 3 projects is as follows:

$$\textit{Electrical Energy Saved} = \left[\frac{1.102\ MWH}{52.930\ MWH}\right] = 2\%$$

$$\textit{Steam Energy Penalty} = \left[\frac{0.884\ MLBS}{115.7\ MLBS}\right] = 0.8\%$$

$$\textit{Energy Cost Savings} = \left[\frac{80{,}693\ \$}{4{,}422{,}942\ \$}\right] = 1.8\%$$

II. NARRATIVE REPORT

A. Entry Interview

Work Plan: An entry interview meeting was conducted at the Corpus Christi Army Depot (CCAD) facility on October 3, 1994. Present at the meeting were representatives of Huitt Zollars Inc., C.A. Pieper, *Project Manager*, and Tom Luckett, *Lighting Designer*, as well as representatives from CCAD, Adan Pena, *Energy Coordinator*, Scott Hinte, *Mechanical Engineer*, and Albert Martinez, *Electrical Engineering Technician*. At that time, a description of the work plan for this study was presented. The work plan was a summary of the individual tasks to be performed to complete the lighting survey and the approximate date that each task was to begin. Each step of the work plan was described in detail to the CCAD staff. The work plan is shown in Figure 1.

Figure 1. Work Plan

10/3/94	Entry Interview Meeting
10/3/94	Lighting & Building Data Collection
10/10/94	Perform ECO Calculations
11/16/94	Interim Findings Submittal
1/27/95	Pre-Final Report Submittal
3/29/95	Final Report Submittal

Data List: After discussing the work plan, the CCAD staff was presented a list of data items to be collected by the study team, shown in Figure 2. This list was a summary of the information required by the surveyors. The study team and CCAD staff discussed the methods by which all of the data on the list were to be obtained. The data concerning the existing lighting systems and light levels were to be collected from the buildings or areas studied and recorded onto preprinted data forms. All other data were to be obtained from the facility personnel responsible for each item. The CCAD personnel provided useful information on past energy conservation efforts, as well as any ongoing or future planned energy conservation measures. Also, they provided direction as to where to obtain other information on the list. Any security passes that the surveyors needed to gain access to the facility were discussed and plans were made to obtain them.

Figure 2. Data Acquisition List

1. Existing lighting systems in buildings.
2. Existing light levels in buildings.
3. Building HVAC system efficiencies and operational hours.
4. Building size, age and remaining useful life.
5. Existing lighting operational periods and area usage.
6. Facility electricity, gas, other utility rates.
7. Facility electricity, gas, other utility consumptions.
8. Utility company rebate programs.
9. Past lighting energy conservation projects.
10. Proposed or planned lighting energy conservation projects.
11. Typical lighting maintenance procedures, costs and materials.
12. Typical lighting retrofit procedures.

ECO List: Following the discussion on the data list, the CCAD personnel were presented a list of specific Energy Conservation Opportunities (ECOs) that the surveyors were looking for. It included three general ways to conserve on lighting energy. The first method reduces lighting energy consumption by simply removing lamps or fixtures from areas which are currently overlighted or which could be modified to reduce the need for the existing quantity of lights. Light levels were to be measured by the surveyors and compared with design standards to determine whether or not an area was overlighted. The second method saves energy by turning lights off with additional switches, motion sensors or daylight sensors. Areas which were partially or intermittently unoccupied, or which had sufficient daylight from windows or skylights were to be located by the surveyors. The third method saves energy by reducing the wattage of the existing light source. The surveyors were to look for inefficient light sources within the buildings. These three general energy conservation strategies were discussed in detail with the CCAD staff, who provided feedback on potential applications at their facilities. The ECO list is shown in Figure 3.

Figure 3. Energy Conservation Opportunity (ECO) List

1. Reduce / Enhance Lighting: Remove Lamps and or Fixtures.
    a) Overlighted areas
    b) Increase daylighting
    c) Lower fixtures
    d) Paint walls and ceiling light color.
2. Improve Lighting Controls: Turn Lights Off.
    a) Occupancy sensors
    b) Additional switches in large areas
3. Improve Lighting Efficiency: Reduce Lighting Wattage
    a) Replace incandescent source with more efficient source
    b) Install more efficient fluorescent lamps / ballasts / reflectors
    c) Replace existing HID with more efficient HID source

B. Data Collection

Building Data: This lighting study at the CCAD was conducted on five (5) buildings, four of them stand alone hangars and the other one a large production and warehouse building with administrative offices. All of the buildings are located at the Corpus Christi Naval Air Station in Corpus Christi, Texas. The navy operates the base and provides the utilities, consisting of electricity, natural gas, water and steam, to the CCAD facilities. The CCAD does however provide it's own facility maintenance with permanent personnel, located in building 8. Mechanical cooling at CCAD is provided by electricity and heating is provided by steam. The Navy purchases the electrical power from the local utility company Central Power and Light (CP&L), and back charges CCAD for it's metered usage. Similarly, they purchase natural gas from the City of Corpus Christi Gas Department and produce steam at a large central boiler plant. The Navy meters CCAD's steam consumption and bills them monthly for they're usage. An analysis of these charges is included in Appendix A.

Included in this study were large portions of Building 8, which is actually comprised of several connected building additions and covers a total of 1,214,055 sqft, including a large hanger, small hangar, machine production areas, engine test facilities, warehouse areas and administrative offices. This building serves as the administrative headquarters for CCAD, as well as a helicopter maintenance facility, 4 days per week, 10 hours per day. The work day is typically from 6:45 am until 5:15 pm. The original portion of the building was constructed around 1942, and the entire facility is expected to be used at least 30 more years.

The exterior doors in the large hangar area and upper portions of some exterior walls in the small hangar area have large glass areas which allow natural light to enter the building. The large hangar doors remain open during the workday, except in inclement weather, and allow much natural light to enter the building.

All of the administrative areas in building 8 are cooled, along with large portions of the production area. Heating is provided for the entire building. The HVAC systems consisted of modular air handling units with chilled water and steam coils, distributed throughout the building. In production areas without cooling, steam fan coil units are used to provide heating. The primary cooling systems consist of a central chiller plant operated by CCAD staff, distributing chilled water through a loop in the building. The steam for heating is provided from the building's steam piping loop, which is served by the base steam distribution system.

Hangars 43 and 47 had nearly identical floor plans and each covered approximately 106,039 sqft. Similarly, hangers 44 and 45 had nearly identical floor plans and each covered approximately 95,072 sqft. All of these hangars are currently used as helicopter repair facilities, 4 days per week, 10 hours per day. They are all well maintained buildings which were constructed around 1942 and are expected to be used by CCAD for approximately another 30 years. The hangars have no cooling in the high bay areas but do have steam fan coil units for heating.

The hangars have large sliding doors on opposite sides which remain open during the workday, except in inclement weather. These doors, as well as the upper portions of the exterior hangar walls, have large window areas which were originally provided to allow natural light to enter the building. The glass in these areas has since been replaced by translucent panels, which allow some daylight into the hangar, but less than the original glass would.

Lighting Data: In order to collect the existing lighting data, the walk through of the buildings was performed. This walk through covered Hangars 43, 44, 45 and 47, as well as production and office areas within building 8. The total area covered by the surveyors was approximately 1,616,277 sqft. During the walk through, the auditors went room by room, recording the quantity and type of existing lighting systems, measured average light levels, and potential ECOs available. These data were recorded onto the data forms included in Appendix C. Building maps are also included in Appendix C, which show room numbers corresponding to those listed on the data forms. This will allow the facility staff, as well as the study team, to readily identify the existing lighting conditions anywhere in the buildings or areas studied.

Lighting in Building 8 consists of aging fluorescent fixtures, mostly all pendent mounted, throughout the production areas as well as the office areas. Most of these older fixtures are combination direct/indirect fixtures, which allow a portion of the light to reflect off of the ceilings. In production areas, these 8' fluorescent strip fixtures are mounted approximately 14' above the floor, and require high output lamps to produce acceptable lighting levels. The newer production areas, as well as the large hangar, are lighted with high pressure sodium fixtures. The study excluded most areas with modern lighting and generally concentrated on the areas with the older lighting. However, the large hangar was included because of it's potential for daylighting. In Hangers 43, 44, 45 and 47, lighting in the high bay areas is provided by 400 W high pressure sodium fixtures, approximately 266 per hangar. This lighting is currently operated during the entire work day, which runs from 6:45 am until 5:15 pm. The total annual lighting energy consumption for the areas studied was calculated at 2,598,077 KWH, see Appendix B.

Maintenance Data: Lighting maintenance at CCAD is difficult due to the size of the facility, the number of light fixtures, and the reduced size of the maintenance staff. Many lights remain burned out for several weeks in some areas, and relamping takes place on a spot basis. Many areas have very old fluorescent lighting which should be replaced whenever possible.

The facility energy coordinator is involved in most of the building maintenance and renovation projects and has directed that all lighting projects use the latest, most efficient light source available. The maintenance staff has started stocking F34T12 and F32T8 fluorescent lamps in an effort to reduce energy consumption. Motion detectors to control lighting were once tried in the restrooms, but problems were encountered with lights going off while the rooms were still occupied. Also tried was an HID dimming system in one of the hangars, but it never operated properly. No other lighting energy conservation projects were planned at the time of this report. The Energy Coordinator should work together with the CCAD Director of Public Works to develop a Standard Specification for all future lighting repair and renovation projects. This will eliminate the inadvertent use of inefficient lighting systems at the facility.

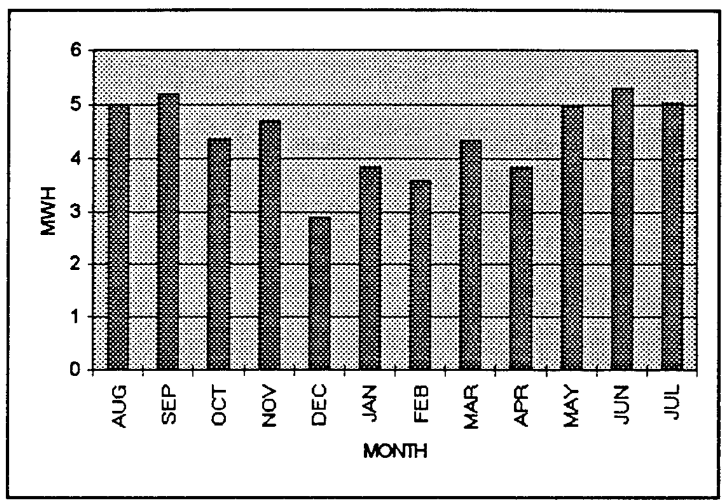
Utility Data: A 12 month utility billing history was obtained from the energy coordinator which covered the period from August, 1993 through July, 1994. This history included all of the metered electric and steam consumption for all the CCAD facilities and is shown in Figure 4. The total cost of electricity for the base year was $3.1 million and the total cost for steam was $1.3 million.

Figure 4. CCAD Base Year Energy and Cost Data

Billing Period	Electrical		Steam	
	Consumption MWH	Cost $	Consumption MLBS	Cost $
AUG	5.004	293,518	6.502	67,947
SEP	5.184	303,994	6.684	69,851
OCT	4.356	255,633	8.869	92,680
NOV	4.675	274,305	10.885	113,749
DEC	2.868	168,579	13.381	139,833
JAN	3.828	224,724	14.947	179,367
FEB	3.584	210,492	13.227	158,721
MAR	4.314	253,150	11.363	136,350
APR	3.816	224,044	6.464	77,569
MAY	4.963	291,117	7.337	88,040
JUN	5.309	311,336	8.469	101,628
JUL	5.029	294,926	7.616	91,389
Total	52.930	3,105,818	115.744	1,317,124

Charts of the base year energy usages were plotted and are shown in Figures 5 and 6. These charts give a visual representation of the energy usage patterns for the year. Looking at Figure 5, it can be seen that the electrical usage almost never falls below 3.5 MWH per month. This is considered a 'baseline' of electrical energy use. It can be assumed that all energy usage above this baseline is consumed by heating and cooling systems, based on the peaks and the months in which they occur. Therefore, the baseline would include all lighting as well as all of the process energy usage. Considering that the calculated lighting energy consumption for the buildings and areas studied amounts to only 0.2 MWH per month, it is reasoned that the process electrical energy usage makes the greatest contribution to the baseline of 3.5 MWH per month. Since this process energy usage appears to be so much greater than that for lighting, the potential for process energy savings is considered very great. Therefore, is recommended that the energy coordinator direct considerable conservation efforts to process energy usage.

Figure 5. CCAD Electrical Usage 1993-94

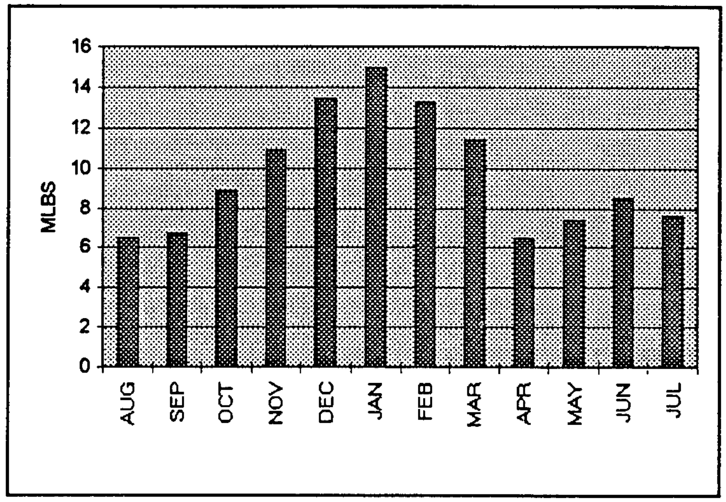


This same observation can be made about steam energy usage, shown in Figure 6. The baseline usage here is around 6.5 Mlbs of steam per month. Since steam is the primary source of heating at CCAD, the obvious peak during the winter months can be considered heating energy.

Therefore, all steam energy usage below the baseline is used for the manufacturing processes. This is a tremendous amount of energy usage and should be considered a large target for potential energy savings.

The utility rates for fiscal year 1994, charged by the Navy for CCAD electricity and steam, were obtained and are included in Appendix A. The current cost for electricity is $0.0585 per KWH with no demand charge, and $0.012 per pound for steam. These rates are reviewed quarterly and adjusted if the Navy decides it to be necessary. These rates are based on the Navy's costs for purchasing electricity and gas from the local utility companies, and includes maintenance costs for distribution equipment as well as steam production costs.

Figure 6. CCAD Steam Usage 1993-94



There is currently no rebate available from the CP&L Co. for lighting energy conservation projects.

C. Plan To Implement Projects:

The analysis of all potential lighting ECOs at the facility has been completed and the grouping of individual ECOs into projects has been determined. These were detailed previously in the Executive Summary. Below is an abbreviated plan for implementation of the recommended projects.

Project 1: The forms DD-1391, cost estimate and associated life cycle cost analysis summary sheet for this project are provided on pages 13 to 16. These are to be submitted for project funding, along with the calculations in Appendix D if required. The recommended plan to implement this project after funding is obtained is as follows:

A. Install approximately 16 ceiling mounted motion sensors in various production storage areas of Building 8 (ECO D-1). These areas are identified on the building maps on pages C-10 and C-12 as room numbers 100, 101, 102, 105, 107, 108 and 131. First, a lighting controls sales representative should be consulted to determine the proper type and quantity of occupancy sensor to be used in each area. Information from a typical occupancy sensor manufacturer is included in the Appendix G. The sensors should most likely be the ceiling mounted type and cover 2,000 sqft of area in a 360° pattern. Once this is determined, contract documents, including engineering drawings and specifications should be produced in order to select a contractor and ensure that the final installation is acceptable. The designer should check the circuiting of the existing 8' fluorescent light fixtures and modify as required to allow the new sensors to turn off the lights during unoccupied periods. After the contract documents are produced and reviewed, then a contract for the work can be obtained.

B. Install 4 photocell sensors and 1 relay panel in the large hangar of Building 8 (ECO D-2). Again, a lighting controls sales representative should be consulted in order to determine the best hardware and software to be used at this facility for this specific application. Typically, the sales representative will furnish a equipment specification to be used by the contractor during construction. A sample specification for this application is provided in Appendix G. Once this is determined, contract documents, including engineering drawings and specifications should be produced in order to select a contractor and ensure that the final installation is acceptable. The designer should ensure that the relays will operate off of a signal from photocell sensors. He should recircuit the 300 existing 400W HPS light fixtures to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. The on/off setpoint of the relays should be adjustable from the relay panel. After the contract documents are produced and reviewed, then a contract for the work can be obtained.

C. Install 4 photocell sensors and 1 relay panel in each of hangars #43, 44, 45 and 47 (ECO D-3). This portion should be implemented in a similar manner to part B above. The designer should recircuit the 266 existing 400W HPS light fixtures in each hangar to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. Relays should operate off of a signal from the photocell sensors. The on/off setpoint of the relays shall be adjustable from the relay panels. After the contract documents are produced and reviewed, then a contract for the work can be obtained.

Project 2: The forms DD-1391, cost estimate and associated life cycle cost analysis summary sheet for this project are provided on pages 17 to 20. These are to be submitted for project funding, along with the calculations in Appendix D if required. The recommended plan to implement this project after funding is obtained is as follows:

Upgrade the existing fluorescent lighting in rooms 3, 4, 5, 6, 7, 11, 12, 13, 14, 22, 23, 25, 26, 27, 31, 45, 46, 47, 49, 95, and 96 in building 8. These rooms are identified on the building maps on page C-11. First, contract documents, including engineering drawings and specifications should be produced. The designer should remove approximately 180 existing pendent mounted, 4 lamp fluorescent light fixtures and replace them with 172 lay-in, 2 lamp, 2x4 fluorescent light fixtures with electronic ballasts and prismatic lenses (ECO D-4). He should locate the new light fixtures over desks or other work tables as required to provide 50 fc at the work station in each room. All switching and circuitry is to remain the same. After the contract documents are produced and reviewed, then a contract for the work can be obtained.

Project 3: The forms DD-1391, cost estimate and associated life cycle cost analysis summary sheet for this project are provided on pages 21 to 24. These are to be submitted for project funding, along with the calculations in Appendix D if required. The recommended plan to implement this project after funding is obtained is as follows:

Replace the pendent mounted fluorescent lighting in the production areas of building 8 with high pressure sodium lighting. The areas are identified as rooms 103, 106, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 127, 128, 129, 130, 131, 132, 134, 136, 137, 138, 139, 142, and 143. These rooms are shown on the building maps on pages C-10 through C-13. First, contract documents, including engineering drawings and specifications should be produced. The designer should remove approximately 3,017 existing pendent mounted, 2 lamp fluorescent light fixtures and replace them with 1,092 low-bay, 400 watt HPS light fixtures with rectangular pattern reflectors and lenses. Information on a sample fixture of this type is included in Appendix G. He should locate the new light fixtures over desks or other work tables as required to provide IES design lighting level at the work station in each room. All switching and circuitry is to remain the same, as much as is possible. After the contract documents are produced and reviewed, then a contract for the work can be obtained.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 5 APR, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
CORPUS CHRISTI ARMY DEPOT, TEXAS	LIGHTING CONTROLS INSTALLATION

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			56.0

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Installation of interior lighting controls for Hangars and Building 8.	EA	1	56.0	56.0
ESTIMATED CONTRACT COST				46.308
CONTINGENCY (0%)				0.0
SIOH				2.547
DESIGN				7.469
TOTAL REQUEST				56.324
TOTAL REQUEST (ROUNDED)				56.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Install 16, ceiling mounted motion sensors in various areas of building 8, shown on building maps as room numbers 100, 101, 102, 105, 107, 108 and 131. Recircuit the existing 8' fluorescent lights as required to allow the sensors to turn off the lights during unoccupied periods.

B. Install 4 photocell sensors and 1 relay panel in the large hangar of building 8. Recircuit the 300 existing lights to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. The relays will operate off of a signal from photocell sensors.

C. Install 4 photocell sensors and 1 relay panel in each of the hangars #43, 44, 45 and 47. Recircuit the 266 existing lights in each hangar to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. The relays will operate off of a signal from photocell sensors.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 5 APR, 1995

3. INSTALLATION AND LOCATION
CORPUS CHRISTI ARMY DEPOT, TEXAS

4. PROJECT TITLE LIGHTING CONTROLS INSTALLATION	5. PROJECT NUMBER

11. REQUIREMENT

The project is required to reduce lighting energy consumption at the Corpus Christi Army Depot facilities. The project provides controls for interior lighting, which will turn off all or a portion of the lights during periods of the day, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these controls will result in the following:

Electrical Savings	367,484	KWH/yr
Steam Penalty	0	lbs/yr
Total Energy Savings	1,254.0	MMBTU/yr
Cost Savings	23,415	$/yr
Payback Period	2.4	yrs
SIR	6.46	

CURRENT SITUATION:
The hangars currently have areas which are overlit by artificial lighting whenever the large doors are open and the sunlight comes in. Also, areas of building 8 have lights burining all day, during unoccupied periods. There is currently no automatic means to turn off the lights in these areas during periods in which this would be acceptable.

IMPACT IF NOT PROVIDED
If this project is not provided, a reduction of 1,254 MMBTU per year of energy and $23,415 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY: PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Controls Installation (ECOs D-1, 2 and 3)

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Installation of motion sensor controls	16	ea	1.1	30.00	528	80.00	1,280	1,808
Installation of power packs	16	ea	1.0	30.00	480	30.00	480	960
Install daylighting control panel, contactors, controller and sensors	1	ea	50.0	30.00	1,500	6,000.00	6,000	7,500
Install daylighting control panel, contactors, controller and sensors	4	ea	50.0	30.00	6,000	6,000.00	24,000	30,000
						10.27		
				SUBTOTAL	8,508		31,760	40,268
				O & P @ 20%	1,702		6,352	6,040
				SUBTOTAL	10,210		38,112	46,308
				DESIGN				7,469
				SUBTOTAL				53,777
				SIOH @ 5.5%				2,547
				TOTAL				$56,324

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT-1
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 46308.	
B. SIOH	$ 2547.	
C. DESIGN COST	$ 7469.	
D. TOTAL COST (1A+1B+1C)	$ 56324.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 56324.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	1254.	$ 21497.	15.61	$ 335568.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		1254.	$ 21497.		$ 335568.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1918.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 28271.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 28271.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 23415.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.41 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 363839.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 6.46
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.18 %

1. COMPONENT		2. DATE
ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	5 APR, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
CORPUS CHRISTI ARMY DEPOT, TEXAS	FLUORESCENT LIGHTING UPGRADE

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			29.0

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Replace existing inefficient fluorescent lighting in office areas of Building 8.	EA	1	29.0	29.0
ESTIMATED CONTRACT COST				26.390
CONTINGENCY (0%)				0.0
SIOH				1.451
DESIGN				1.583
TOTAL REQUEST				29.424
TOTAL REQUEST (ROUNDED)				29.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Remove 180 existing pendent mounted, 4 lamp fluorescent light fixtures and replace them with 172 lay-in, 2 lamp, 2x4 fluorescent light fixtures with electronic ballasts and prismatic lenses. This should be done in the administrative areas of Building 8. Locate the new light fixtures over desks or other work tables as required to provide 50 fc at the work station in each room. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 5 APR, 1995

3. INSTALLATION AND LOCATION
CORPUS CHRISTI ARMY DEPOT, TEXAS

4. PROJECT TITLE FLUORESCENT LIGHTING UPGRADE	5. PROJECT NUMBER

11. REQUIREMENT

The project is required to reduce lighting energy consumption at the Corpus Christi Army Depot facilities. The project provides new, more efficient interior lighting, which will save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of this lighting will result in the following:

Electrical Savings	48,052	KWH/yr
Steam Penalty	53.8	lbs/yr
Total Energy Savings	115.7	MMBTU/yr
Cost Savings	3,147	$/yr
Payback Period	9.3	yrs
SIR	1.66	

CURRENT SITUATION:
Some of the administrative office areas in Building 8 have 4 lamp, pendent mounted fluorescent light fixtures. These fixtures typically have louvers on the bottom and apertures in the top of the enclosure for partial indirect lighting off of the ceiling. Because only about 30% of the light that hits the ceiling is reflected back down to the work plane, a good deal of light is wasted. The louvered bottoms trap light within the fixture, lowering it's efficiency. These fixtures should be replaced with 2 lamp, 2x4 lay-in troffers with prismatic lenses. The offices generally have suspended ceilings which would easily accommodate the new fixtures. Because the new fixtures would direct all of the light down to the work plane, the number of lamps required to maintain design lighting levels would be reduced. The existing average light levels were measured and recorded on the data sheets, along with the number of fixtures in each room. Some of the rooms had average light levels that were somewhat above that recommended for their specific types of area.

IMPACT IF NOT PROVIDED
If this project is not provided, a reduction of 115.7 MMBTU per year of energy and $3,147 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Fluorescent Lighting Upgrade In Office Areas (ECO-D-4)

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing pendent fluorescent light fixtures	180	ea	0.3	30.00	1,620			1,620
Miscellaneous conduit, wire and recircuiting	172	ea	1.0	30.00	5,160	5.00	860	6,020
Installation of new two lamp, lay-in fluorescents with T8 lamps	172	ea	0.3	30.00	1,548	80.00	13,760	15,308
SUBTOTAL					8,328		14,620	22,948
O & P @ 20%					1,666		2,924	3,442
SUBTOTAL					9,994		17,544	26,390
DESIGN @ 6%								1,583
SUBTOTAL								27,973
SIOH @ 5.5%								1,451
TOTAL								$29,424

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT-2
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 26390.		
B. SIOH	$ 1451.		
C. DESIGN COST	$ 1583.		
D. TOTAL COST (1A+1B+1C)	$ 29424.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 29424.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	164.	$ 2811.	15.61	$ 43879.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
L. OTHER	$ 13.16	-48.	$ -636.	14.74	$ -9369.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		116.	$ 2175.		$ 34510.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 972.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 14327.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 14327.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 3147.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.35 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 48837.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.66
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.75 %

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 5 APR, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
CORPUS CHRISTI ARMY DEPOT, TEXAS	FLUORESCENT TO HID LIGHTING RETROFIT

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			477.0

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Replace existing inefficient fluorescent lighting in production areas of Building 8 with high pressure sodium light fixtures.	EA	1	477.0	477.0
ESTIMATED CONTRACT COST				428.059
CONTINGENCY (0%)				0.0
SIOH				23.543
DESIGN				25.684
TOTAL REQUEST				477.286
TOTAL REQUEST (ROUNDED)				477.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Remove 3,017 existing pendent mounted, 2 lamp fluorescent light fixtures and replace them with 1,092 low-bay, 400 watt HPS light fixtures with rectangular pattern reflectors and lenses. This should be done in the production and warehouse areas of Building 8. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same, as much as is possible.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 5 APR, 1995

3. INSTALLATION AND LOCATION
CORPUS CHRISTI ARMY DEPOT, TEXAS

4. PROJECT TITLE FLUORESCENT TO HID LIGHTING RETROFIT	5. PROJECT NUMBER

11. REQUIREMENT

The project is required to reduce lighting energy consumption at the Corpus Christi Army Depot facilities. The project provides new, more efficient interior lighting, which will save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of this lighting will result in the following:

Electrical Savings	686,616	KWH/yr
Steam Penalty	830.7	lbs/yr
Total Energy Savings	1,597.5	MMBTU/yr
Cost Savings	54,131	$/yr
Payback Period	8.8	yrs
SIR	1.74	

CURRENT SITUATION:
Most of the production areas in Building 8 have 2 lamp, pendent mounted fluorescent light fixtures. These fixtures typically have apertures in the top of the enclosure for partial indirect lighting off of the ceiling. Because only about 30% of the light that hits the ceiling is reflected back down to the work plane, a good deal of light is wasted. Because of the high mounting height, 110 watt high-output lamps are required to produce acceptable lighting levels.

These fixtures should be replaced with 400W HPS, low-bay light fixtures with rectangular pattern reflectors and lenses. The production areas generally have open beam ceilings which would easily accommodate the new fixtures. Because the new fixtures would direct all of the light down to the work plane, and because they produce a greater amount of light, less fixtures would be required to maintain design lighting levels. The existing average light levels were measured and recorded on the data sheets, along with the number of fixtures in each area.

IMPACT IF NOT PROVIDED
If this project is not provided, a reduction of 1,597.5 MMBTU per year of energy and $54,131 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Fluorescent Lighting Replacement With HID in Production Areas (ECO D-5)

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing pendent fluorescent light fixtures	3,017	ea	0.3	30.00	27,153			27,153
Miscellaneous conduit, wire and recircuiting	1,092	ea	1.0	30.00	32,760	5.00	5,460	38,220
Installation of new 400W HPS light fixtures	1,092	ea	0.3	30.00	9,828	272.00	297,024	306,852
				SUBTOTAL	69,741		302,484	372,225
				O & P @ 20%	13,948		60,497	55,834
				SUBTOTAL	83,689		362,981	428,059
				DESIGN @ 6%				25,684
				SUBTOTAL				453,743
				SIOH @ 5.5%				23,543
				TOTAL				$477,286

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT-3
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 428059.		
B. SIOH	$ 23543.		
C. DESIGN COST	$ 25684.		
D. TOTAL COST (1A+1B+1C)	$ 477286.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 477286.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	2343.	$ 40166.	15.61	$ 626989.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
L. OTHER	$ 13.16	-746.	$ -9816.	14.74	$ -144688.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		1597.	$ 30350.		$ 482301.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 23781.
(1) DISCOUNT FACTOR (TABLE A)	14.74	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 350532.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 350532.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 54131.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.82 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 832833.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.74
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.01 %

APPENDIX A

ENERGY COST ANALYSIS

APPENDIX A
ENERGY COST ANALYSIS

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APPENDIX A
ENERGY COST ANALYSIS

A. Electrical Energy Cost Analysis

The CCAD is supplied electrical power through the Corpus Christi Naval Air Station, who purchases it from Central Power and Light Company (CP&L). The Navy maintains all of the electrical distribution equipment on the base, and meters all of the base residents separately. Currently, they only meter for KWH, but have plans to begin metering for KW demand as well. Since only KWH is metered at this time, the Navy simply divides up the monthly charges from CP&L, along with maintenance cost, and apportions it out to it's customers at a flat $/KWH rate. This rate is calculated annually. The current rate for electrical energy consumption at CCAD is as follows:

Energy Charge: $0.0585/KWH

For the purposes of the Life Cycle Cost Analysis, using the computer program LCCID, the energy charge in units of MMBTUs is as follows:

$$\frac{\$0.0585}{KWH} x \frac{KWH}{3413\ BTU} x \frac{1{,}000{,}000\ BTU}{MMBTU} = \frac{\$17.14}{MMBTU}$$

B. Steam Energy Cost Analysis

The CCAD is supplied steam for process and heating through the Corpus Christi Naval Air Station, who generates the steam in a gas fired central plant. The Navy maintains all of the steam distribution equipment on the base, and meters all of the base residents separately. The saturated steam is supplied at approximately 316 F, and therefore has a latent heat content of 898 BTU/lb, per steam tables. The Navy purchases it's gas from the City of Corpus Christi Gas Department, and divides up it's monthly billings in a similar manner to that of the electrical billing. The current rate that the Navy charges to CCAD for steam is as follows:

Steam Charge: $12.00/klb

For the purposes of the Life Cycle Cost Analysis, using the computer program LCCID, the energy charge in units of MMBTUs is as follows:

$$\frac{\$12.00}{klb} x \frac{klb}{1000\ lb} x \frac{lb}{898\ BTU} x \frac{1{,}000{,}000\ BTU}{MMBTU} = \frac{\$13.36}{MMBTU}$$

APPENDIX B

DETAILED CALCULATIONS

APPENDIX B
DETAILED CALCULATIONS

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APPENDIX B
DETAILED CALCULATIONS

A. Annual Heating and Cooling Percentage Calculations

The percentage of the year that the building's heating systems are in operation (H_H) and the percentage of the year that the building's cooling systems are in operation (H_C) were determined to be used in the heating energy penalty and the cooling energy savings calculations. For the purposes of this study, all building heating systems are assumed to operate whenever the outside air temperature is below 60 F and all building cooling systems are assumed to operate whenever the outside air temperature is above 70 F. These annual hours were obtained from Engineering Weather Data, TM 5-785. The weather data in this technical manual with the closest proximity to CCAD was obtained from the Corpus Christi Naval Air Station in Corpus Christi, Texas. This data showed an annual total of 2,348 hours below 60 F and 5,426 hours above 70 F. Using these figures, the values of H_H and H_C were determined as follows:

$$H_H = \frac{2{,}348\ hrs}{8{,}760\ hrs} = 0.26 \qquad H_C = \frac{5{,}426\ hrs}{8{,}760\ hrs} = 0.61$$

B. Heating and Cooling System Efficiency

In order to calculate the heating energy penalties and cooling energy savings, the heating and cooling system efficiencies were determined. Building 8 has some areas which are both heated and cooled and other areas which have only heating. Hangars #43, 44, 45 and 47 have only heating in the high bay areas.

The primary cooling source in building 8 is a central chilled water plant. Because of the age of the system, the specific energy consumption for this system was estimated to be about 1.2 KW per ton of cooling provided. This translates into a cooling system efficiency (EER) as follows:

$$EER = \frac{12{,}000\ BTU}{ton\text{-}hr} \ x\ \frac{ton}{1.2\ KW} \ x\ \frac{KW}{1{,}000\ W} = 10\ \frac{BTU}{W\text{-}hr}$$

The primary heating source for all of building 8 as well as Hangars #43, 44, 45 and 47 is the central boiler plant, operated by the Naval Air Station. The Navy facilities personnel have determined the boiler system efficiency (EFF_H) to be approximately 73%.

$$EFF_H = 0.73$$

C. Annual Hours of Lighting Operation

The production and administrative areas of the CCAD facility are operated basically 4 days per week, and 10 hours per day. The facility is operational year round, 52 weeks per year. For the purposes of this study, the annual Lighting Operational Period (H) is calculated as follows:

Assumptions:
- 10 hrs per day
- 4 days per week
- 52 weeks per year

$$H = 10\ \frac{hrs}{day}\ x\ 4\ \frac{days}{week}\ x\ 52\ \frac{wks}{yr} = 2{,}080\ \frac{hrs}{yr}$$

D. Total Lighting Energy Consumption

The total annual lighting energy consumption for the CCAD areas studied was computed to be used as a yardstick against calculated ECO energy savings. The data for this calculation was taken from the data sheets included in Appendix C. The following sample calculation illustrates the procedure used.

Sample Calculation: Room 3, Office (from data sheets, see Appendix C)
- 6 fixtures
- 4 lamps per fixture
- 34 watts per lamp
- 1.2 ballast factor

$$6\ fixtures\ x\ \frac{4\ lamps}{fixture}\ x\ \frac{34\ W}{lamp}\ x\ 1.2\ ballast\ factor\ x\ \frac{2{,}080\ hrs}{yr}\ x\ \frac{1\ KW}{1{,}000\ W} = 2{,}037\ \frac{KWH}{yr}$$

The total electrical energy consumed by the lighting systems in the areas studied was calculated to be 2,598,077 KWH/yr. In terms of BTUs, this amounts to 8867.2 MMBTU/yr of energy currently used for lighting. The room by room summation of lighting energy consumption, based on the data sheets, is shown below in Figure B-1.

Figure B-1. Total Lighting Energy Consumption

ROOM NO.	ROOM FUNCTION	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	LAMP WATTS	FIXTURE DESCRIPTION	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR
3	OFFICE	6	4	34	PENDENT FLUOR.	2080	2,037
4	OFFICE	4	4	34	PENDENT FLUOR.	2080	1,358
5	OFFICE	4	4	34	PENDENT FLUOR.	2080	1,358
6	OFFICE	4	4	34	PENDENT FLUOR.	2080	1,358
6	OFFICE	1	2	34	PENDENT FLUOR.	2080	170
7	OFFICE	3	4	34	PENDENT FLUOR.	2080	1,018
7	OFFICE	1	2	34	PENDENT FLUOR.	2080	170
11	COPY ROOM	3	4	34	PENDENT FLUOR.	2080	1,018
12	OFFICE	6	4	34	PENDENT FLUOR.	2080	2,037
13	OFFICE	6	4	34	PENDENT FLUOR.	2080	2,037
14	COPY ROOM	2	4	34	PENDENT FLUOR.	2080	679
22	OFFICE	6	4	34	PENDENT FLUOR.	2080	2,037
23	OFFICE	4	4	34	PENDENT FLUOR.	2080	1,358
25	OFFICE	3	4	34	PENDENT FLUOR.	2080	1,018
26	OFFICE	4	4	34	PENDENT FLUOR.	2080	1,358
27	OFFICE	8	4	34	PENDENT FLUOR.	2080	2,716
31	OFFICE	12	2	34	PENDENT FLUOR.	2080	2,037
45	OFFICE	1	4	34	PENDENT FLUOR.	8736	1,426
46	OFFICE	1	4	34	PENDENT FLUOR.	2080	339
46	OFFICE	1	2	75	PENDENT FLUOR.	2080	374
47	OFFICE	2	3	34	PENDENT FLUOR.	2080	509
47	OFFICE	2	3	75	PENDENT FLUOR.	2080	1,123
48	OFFICE	3	2	75	PENDENT FLUOR.	2080	1,123
49	OFFICE	2	3	75	PENDENT FLUOR.	2080	1,123
49	OFFICE	2	3	34	PENDENT FLUOR.	2080	509
52	OFFICE	4	4	75	PENDENT FLUOR.	2080	2,995
54	OFFICE	2	2	75	PENDENT FLUOR.	2080	749

Figure B-1. Total Lighting Energy Consumption (Cont.)

ROOM NO.	ROOM FUNCTION	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	LAMP WATTS	FIXTURE DESCRIPTION	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR
61	TELEPHONE ROOM	2	2	110	PENDENT FLUOR.	2080	1,098
95	INSTRUMENTATION	96	4	34	PENDENT FLUOR.	2080	32,588
96	OFFICE	2	2	34	PENDENT FLUOR.	2080	339
99	LARGE HANGAR - BLDG 8	300	1	400	HIGH BAY HID	2080	299,520
100	TEST DATA WAREHOUSE	18	2	110	PENDENT FLUOR.	2080	9,884
101	ASSEMBLY	58	2	110	PENDENT FLUOR.	2080	31,849
102	ASSEMBLY	28	2	75	PENDENT FLUOR.	2080	10,483
103	CORRIDOR	16	3	110	PENDENT FLUOR.	2080	13,179
104	PRODUCTION	18	3	75	PENDENT FLUOR.	2080	10,109
105	JOINER SHOP	105	2	75	PENDENT FLUOR.	2080	39,312
106	PRODUCTION	11	2	110	PENDENT FLUOR.	2080	6,040
107	MAINTENANCE	56	2	110	PENDENT FLUOR.	2080	30,751
108	MAINTENANCE	7	2	110	PENDENT FLUOR.	2080	3,844
109	PM TEAM	18	2	110	PENDENT FLUOR.	2080	9,884
110	PRODUCTION	4	2	75	PENDENT FLUOR.	2080	1,498
111	MANUFACTURING	72	2	110	PENDENT FLUOR.	2080	39,537
112	MANUFACTURING	54	2	110	PENDENT FLUOR.	8736	124,540
113	TEST CELL	16	2	110	PENDENT FLUOR.	2080	8,786
114	MANUFACTURING	202	2	110	PENDENT FLUOR.	2080	110,922
115	MANUFACTURING	115	2	110	PENDENT FLUOR.	2080	63,149
116	CONTAINER REPAIR	96	2	110	PENDENT FLUOR.	2080	52,716
117	ENGINE REPAIR	75	2	110	PENDENT FLUOR.	2080	41,184
118	ENGINE PRODUCTION	30	2	110	PENDENT FLUOR.	2080	16,474
119	PLATING	153	2	110	PENDENT FLUOR.	2080	84,015
120	MACHINE SHOP	187	2	110	PENDENT FLUOR.	2080	102,685
121	WELDING	115	2	110	PENDENT FLUOR.	2080	63,149
122	TOOL CRIB	48	2	110	PENDENT FLUOR.	2080	26,358

Figure B-1. Total Lighting Energy Consumption (Cont.)

ROOM NO.	ROOM FUNCTION	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	LAMP WATTS	FIXTURE DESCRIPTION	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR
123	STAGING	80	2	110	PENDENT FLUOR.	2080	43,930
124	MACHINE SHOP	65	2	110	PENDENT FLUOR.	2080	35,693
125	HOT SECTION	65	2	110	PENDENT FLUOR.	2080	35,693
126	PRODUCTION CONTROL	65	2	75	PENDENT FLUOR.	2080	24,336
127	SMALL PARTS	68	2	110	PENDENT FLUOR.	2080	37,340
128	PRODUCTION	85	2	110	PENDENT FLUOR.	2080	46,675
129	PRODUCTION	140	2	110	PENDENT FLUOR.	2080	76,877
130	GLASS & PLASTIC	45	2	110	PENDENT FLUOR.	2080	24,710
131	MANUFACTURING	25	2	110	PENDENT FLUOR.	2080	13,728
132	FOUNDRY	55	2	110	PENDENT FLUOR.	2080	30,202
133	FOUNDRY OFFICE	18	2	110	PENDENT FLUOR.	2080	9,884
134A	STAGE KIT AREA	155	2	110	PENDENT FLUOR.	2080	85,114
134B	STAGE KIT AREA	55	2	110	PENDENT FLUOR.	2080	30,202
135	TOOL / PLAN	18	2	110	PENDENT FLUOR.	2080	9,884
136	METAL SPRAY	204	2	110	PENDENT FLUOR.	2080	112,020
137	METAL SHOP	148	2	110	PENDENT FLUOR.	8736	341,333
138	ENGINE ASSEMBLY	240	2	110	PENDENT FLUOR.	2080	131,789
139	CORRIDOR	55	2	110	PENDENT FLUOR.	2080	30,202
140	OFFICE	6	1	150	SOCKET INC.	2080	1,872
141	OFFICE	5	2	110	PENDENT FLUOR.	2080	2,746
142	MACHINE SHOP	230	2	110	PENDENT FLUOR.	2080	126,298
143	GEARBOX	145	2	110	PENDENT FLUOR.	2080	79,622
	HANGAR #43	266	1	400	HIGH BAY HID	2080	265,574
	HANGAR #44	266	1	400	HIGH BAY HID	2080	265,574
	HANGAR #45	266	1	400	HIGH BAY HID	2080	265,574
	HANGAR #47	266	1	400	HIGH BAY HID	2080	265,574
TOTAL LIGHTING ENERGY							2,598,077

APPENDIX C

DATA FORMS

APPENDIX C
DATA FORMS

TABLE OF CONTENTS

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
3 OFFICE	50	6	4	34W.	FL. LOUVER DIR./INDIRECT	10	4	REPLACE WITH (4) 2 LAMP RECESSED LAY-IN
4 OFFICE	50	4	4	34W.	" "	10	4	" " "
5 OFFICE	50	4	4	34W.	" "	10	4	" " "
6 OFFICE	50	4 1	4 2	34W. 34W.	" "	10	4	" " "
7 OFFICE	50	3 1	4 2	34W. 34W.	" "	10	4	" " "
8 OFFICE	60	6	2	40W.	RECESSED	10	4	
11 COPY ROOM	90	3	4	40W.	FL. LOUVER DIR./INDIRECT	10	4	REPLACE WITH (2) 2LAMP RECESSED LAY-IN
12 OFFICE	70	6	4	34W.	" "	10	4	REPLACE WITH (6) 2LAMP RECESSED LAY-IN
13 OFFICE	70	6	4	34W.	" "	10	4	" " "
14 COPY ROOM	55	2	4	34W.	" "	10	4	REPLACE WITH (2) 2 LAMP RECESSED LAY-IN
22 OFFICE	83	6	4	34W.	" "	10	4	REPLACE WITH (6) 2LAMP RECESSED LAY-IN

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ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
23 OFFICE	50	4	4	34W.	FL. LOUVER DIR./INDIRECT	10	4	REPLACE WITH (4) 2LAMP RECESSED LAY-IN
24 STAIR WELL	12	3	2	40W.	SURFACE POLY WRAP	24	7	
25 OFFICE	50	3	4	34W.	FL. LOUVER DIR./INDIRECT	10	4	REPLACE WITH (4) 2LAMP RECESSED LAY-IN
26 OFFICE	65	4	4	34W.	" "	10	4	" " "
27 OFFICE	60	8	4	34W.	" "	10	4	REPLACE WITH ( ) 2LAMP RECESSED LAY-IN
31 OFFICE	75	12	2	40W.	" "	10	4	REPLACE WITH ( ) 2LAMP RECESSED LAY-IN
45 OFFICE	35	1	4	40W.	CHAIN MTD. FLUOR.	24	7	REPLACE
46 OFFICE	30	1 1	4 2	40W. 75W.	" "	24	7	REPLACE
47 OFFICE	45	2 2	3 3	40W. 75W.	FL. PENDANT DIR./INDIRECT	10	4	
48 OFFICE	60	3	2	75W.	" "	10	4	
49 OFFICE	45	2 2	3 3	40W. 75W.	" "	10	4	

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
50 OFFICE	45	4	4	40W.	RECESSED LAY-IN	10	4	
51 OFFICE AREA	50	56	2	75W.	SURFACE MTD. 8' FL.	10	4	
52 OFFICE	80	4	4	75W.	PENDANT MTD. 8' FL.	10	4	
53 OFFICE	30	8 7	4 2	40W.	SURFACE MTD 4' FL.	10	4	
54 OFFICE	65	2	2	75W.	PENDANT MTD. 8' FL.	10	4	
61 TELEPHONE ROOM	50	2	2	110W. HO.	PENDANT MTD. 8' FL.	10	5	
95 INSTRUMENTATION	60	96	4	34W. (50%) 40W. (50%)	PENDANT MTD. FL. LOUVER	10	4	
96 OFFICE	25	2	2	40W.	" "	10	4	
99 LARGE HANGER	30	300	1	400W. HPS	HIGH BAYS	10	5	
100 TEST DATA WAREHOUSE	60	18	2	110W. HO 800MA	PENDAND MTD 8' FL.	10	5	PHOTO CELL CONTROL
101 ASSEMBLY	100	58	2	" "	" "	10	5	PHOTO CELL CONTROL

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
102 ASSEMBLY	50	28	2	75 W.	PENDANT MTD. 8' FL.	10	5	MOTION SENSOR CONTROL
103 CORRIDOR	15	16	3	110W. HO. 800MA	" "	10	5	
104 PRODUCTION		18	3	75 W.	" "			
105 JOINER SHOP	60	105	2	75 W.	" "	10	4	MOTION SENSOR CONTROL
106 PRODUCTION	50	11	2	110W. HO 800MA	" "	10	4	
107 MAINT.	50	56	2	" "	" "	10	4	MOTION SENSOR CONTROL
108 MAINT.	50	7	2	" "	" "	10	4	" " "
109 FM TEAM	100	18	2	110W. HO 1500MA	" "	10	4	LOWER FIXTURES
110 PRODUCTION	50	4	2	75 W.	" "	10	4	
111 MFG.	45	72	2	110W. HO 800MA	" "	10	4	FL
112 MFG.	45	54	2	" "	" "	10	4	"

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
113 TEST CELL	55	16	2	110W. HO 800MA	PENDANT MTD. 8' FL.	10	4	[illegible]
114 MFG.	60	202	2	" "	" "	10	4	
115 MFG.	50	115	2	" "	" "	10	4	
116 CONTAINER REPAIR		96	2	" "	" "	10	4	
117 ENGINE REPAIR	30	75	2	" "	" "	10	4	
118 ENGINE PRODUCTION	20	30	2	" "	" "	10	4	
119 PLATING	49	153	2	" "	" "	10	4	
120 MACHINE SHOP	50	187	2	" "	" "	10	4	
121 WELDING	60	115	2	" "	" "	10	4	
122 TOOL CRIB	70	48	2	" "	" "	10	4	
123 STAGGING	10	80	2	" "	" "	10	5	

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
124 MACHINE SHOP	60	65	2	110W. HO 800MA	PENDANT MTD. 8' FL.	10	4	
125 HOT SECTION	40	65	2	" "	" "	10	4	
126 PRODUCTION CONTROL	60	65	2	75W.	" "	10	4	MTD. AT 8'-0" AFF.
127 SMALL PARTS	62	68	2	110W. HO. 800 MA	" "	10	4	
128 PRODUCTION	50	85	2	" "	" "	10	4	
129 PRODUCTION	60	140	2	" "	" "	10	4	
130 GLASS & PLASTIC	35	45	2	" "	" "	10	4	
131 MFG.	30	25	2	" "	" "	10	4	MOTION SENSOR
132 FOUNDRY	30	55	2	" "	" "	10	4	
133 FOUNDRY OFFICE	50	18	2	" "	" "	10	4	MTD. AT 8'-0" AFF.

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

DATE: 10-4-94 SURVEYOR: LUCKETT BUILDING: CCAD #8

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
134(A) STAGE KIT AREA	20	155	2	110W. HO 800 MA	PENDANT MTD. 8'FL.	10	5	
134(B) STAGE KIT AREA	45	55	2	" "	" "	10	4	MTD. AT 10'-0" AFF.
135 TOOL/PLAN	30	18	2	" "	" "	10	4	MTD. AT 8'-0" AFF.
136 METAL SPRAY	30	204	2	" "	" "	10	4	
137 METAL SHOP	65	148	2	" "	" "	10	4	
138 ENGINE ASSEMBLY	90	240	2	" "	" "	10	4	
139 CORRIDOR	12	55	2	" "	" "	10	4	
140 OFFICE	10	6	1	PS 150W. INCANDESCENT	SOCKET	10	4	
141 OFFICE	35	5	2	110W. HO. 800 MA.	PENDANT MTD. 8'FL.	10	4	MTD. AT 10'-0" AFF.
142 MACHINE SHOP	40	230	2	" "	" "	10	4	
143 GEARBOX	60	145	2	" "	" "	10	4	

ENERGY CONSERVATION OPPORTUNITY (ECO) DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

DATE: 10/4/94 SURVEYOR: PIEPER BUILDING: CCAD HANGAR #43, 44, 45, 47

ROOM NO. AND USE	AVG. FC	QTY FIXTURES	LAMPS PER FIXTURE	LAMP WATTS AND TYPE	FIXTURE DESCRIPTION	HRS/DY	DY/WK	ECO DESCRIPTION
HANGAR #43 HIGH BAY	75	266	1	400 W HPS	HIGH BAY HID	10	4	
HANGAR #44 HIGH BAY	75	266	1	400 W HPS	HIGH BAY HID	10	4	
HANGAR #45 HIGH BAY	75	266	1	400 W HPS	HIGH BAY HID	10	4	
HANGAR #47 HIGH BAY	75	266	1	400 W HPS	HIGH BAY HID	10	4	

BUILDING DATA SHEET

Huitt-Zollars, Inc.
CONSULTING ENGINEERS

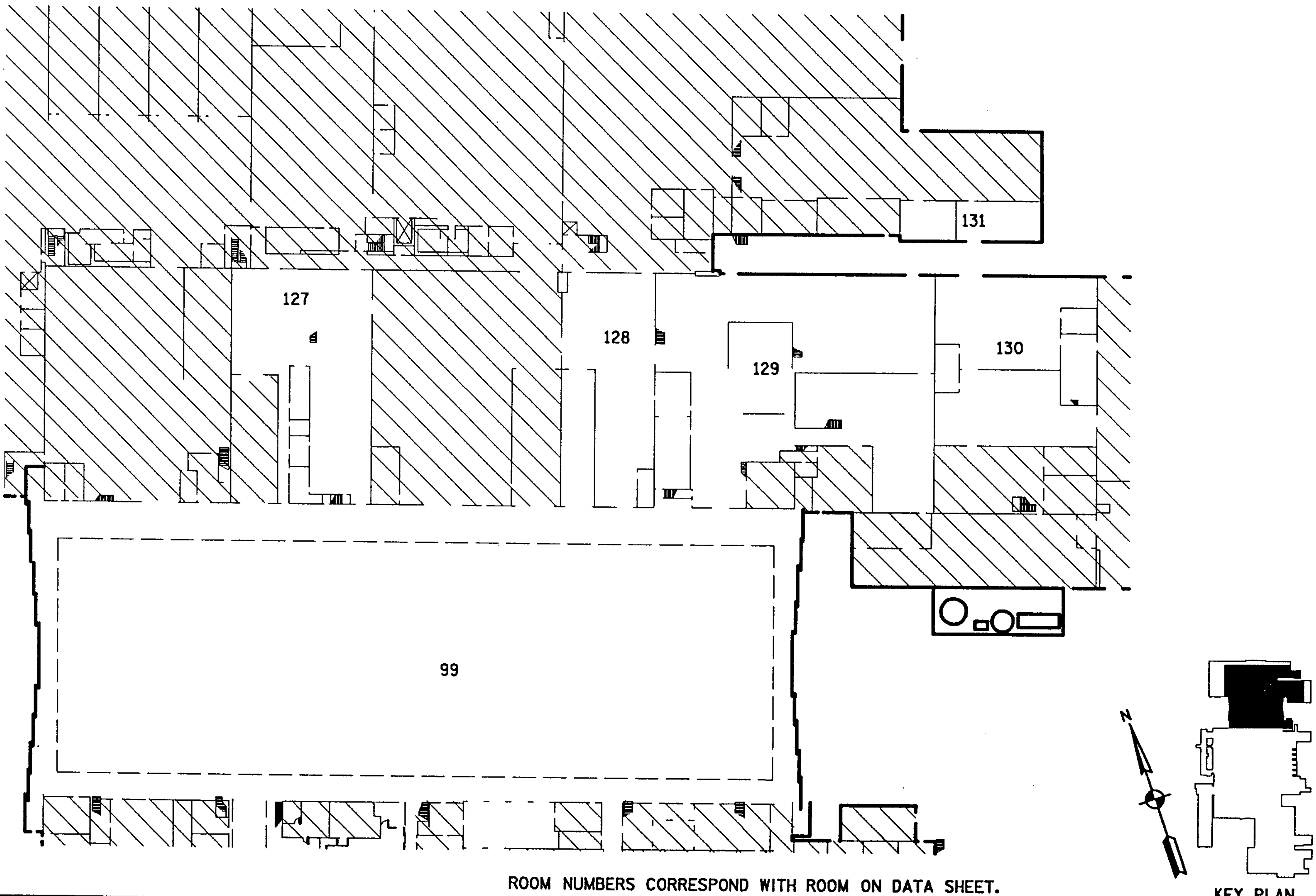
DATE: 10/3/94 SURVEYOR: PIEPER FACILITY: CCAD

BLDG. NO.	BUILDING USE	GROSS SQFT	NO. OF FLOORS	APPROX. AGE	YEARS LEFT	COOLING SYSTEM TYPE	COOLING SYSTEM EER	COOLING SYSTEM MOS/YR	HEATING SYSTEM TYPE	HEATING SYSTEM EFF %	HEATING SYSTEM MOS/YR	HEATING SYSTEM % BLDG
43	HANGAR, REPAIR		1			NONE			STEAM	70	3 1/2	100
44	HANGAR, REPAIR		1			NONE			STEAM	70	3 1/2	100
45	HANGAR, REPAIR		1			NONE			STEAM	70	3 1/2	100
47	HANGAR, REPAIR		1			NONE			STEAM	70	3 1/2	100
8	ADMIN. OFFICES		1			CHW	10	6 1/2	STEAM	70	3 1/2	100
8	HANGARS		1			NONE			STEAM	70	3 1/2	100
8	MACHINE AREAS		1			CHW	10	6 1/2	STEAM	70	3 1/2	100
8	STORAGE, WAREHOUSE		1			NONE			STEAM	70	3 1/2	100

NOTES:

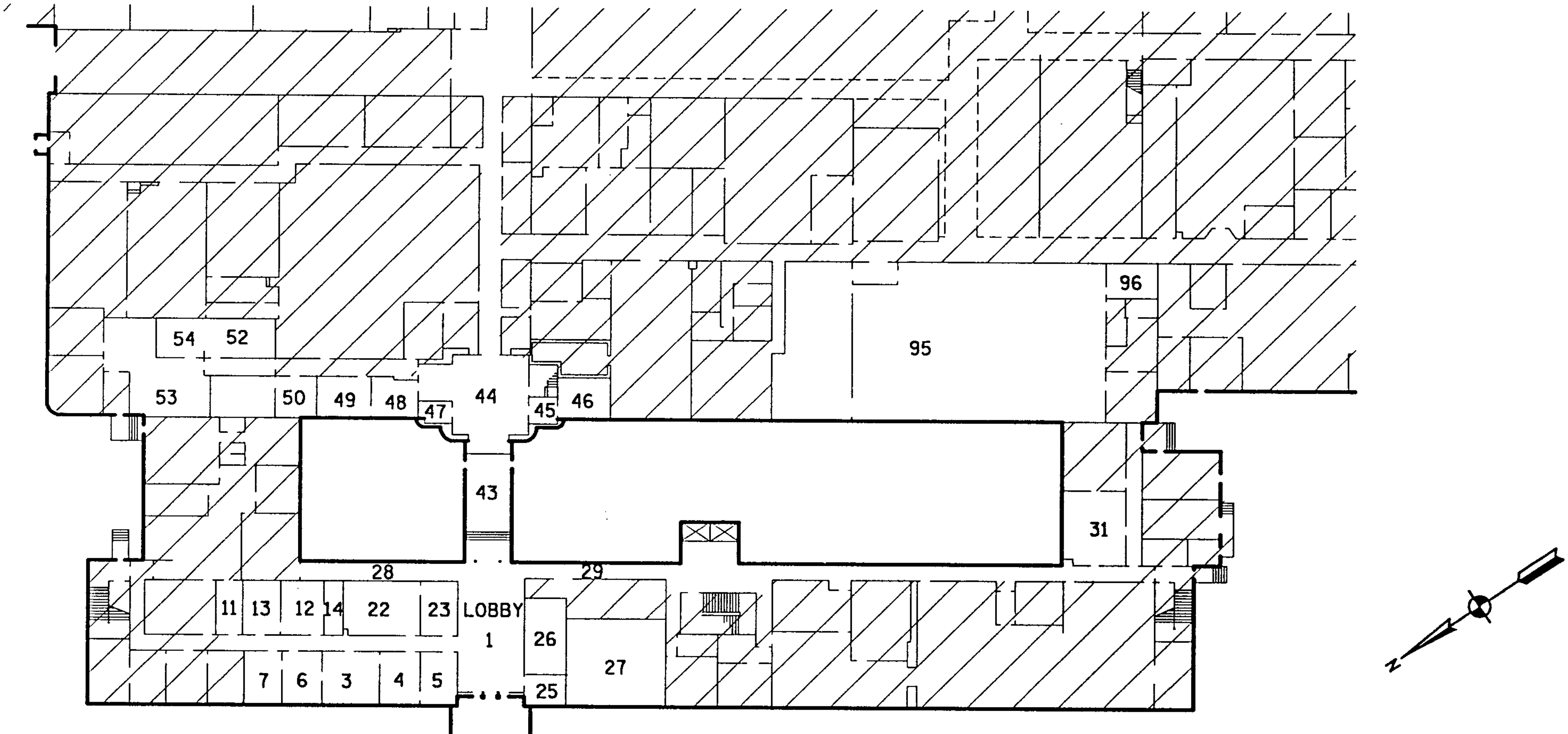
1. BLDG. 8 HAS SOME AREAS SERVED BY CENTRAL CHW PLANT FOR COOLING. EST. 1.2 KW/TON.
2. ALL STEAM SUPPLIED BY CENTRAL BOILER PLANT @ 316°F, SATURATED, 898 BTU/lb.

EER = COOLING SYSTEM EFFICIENCY (BTUH/WATT), EFF = HEATING SYSTEM EFFICIENCY, MOS/YR. = ANNUAL MONTHS OF OPERATION



ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

HUITT ~ ZOLLARS ENGINEERS/ARCHITECTS 512 MAIN STREET, SUITE 1500 FORT WORTH, TEXAS 76102-3922 (817)335-3000/METRO 429-1291	CORPUS CHRISTI ARMY DEPOT	BUILDING 8 AREA "A"



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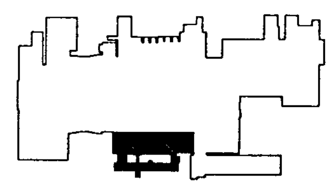


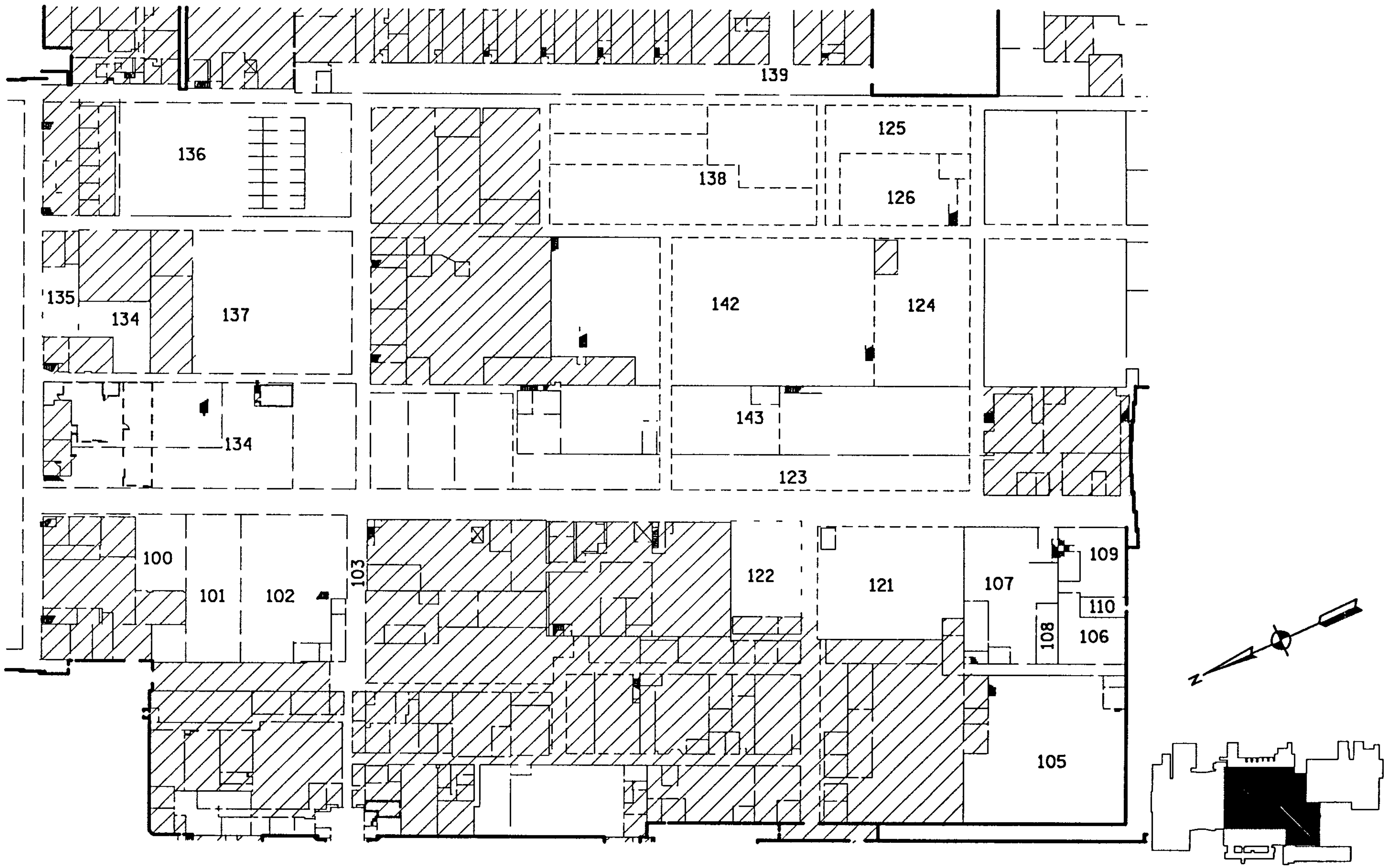
KEY PLAN

HUITT ~ ZOLLARS
ENGINEERS/ARCHITECTS

512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817)335-3000/METRO 429-1291

CORPUS CHRISTI
ARMY DEPOT

BUILDING 8
AREA "B"



ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

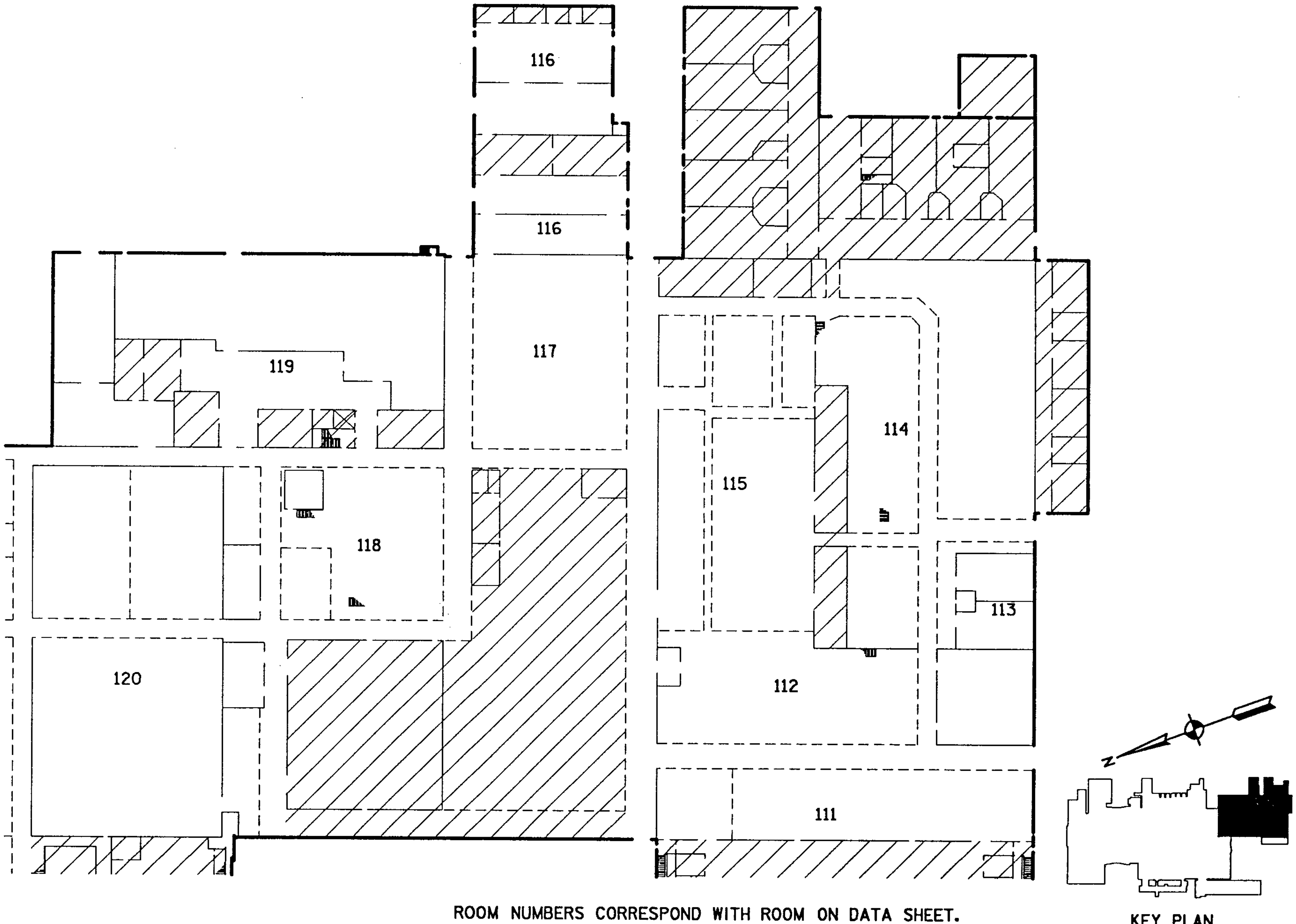
KEY PLAN

HUITT ~ ZOLLARS
ENGINEERS/ARCHITECTS

512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817)335-3000/METRO 429-1291

CORPUS CHRISTI
ARMY DEPOT

BUILDING 8
AREA "C"

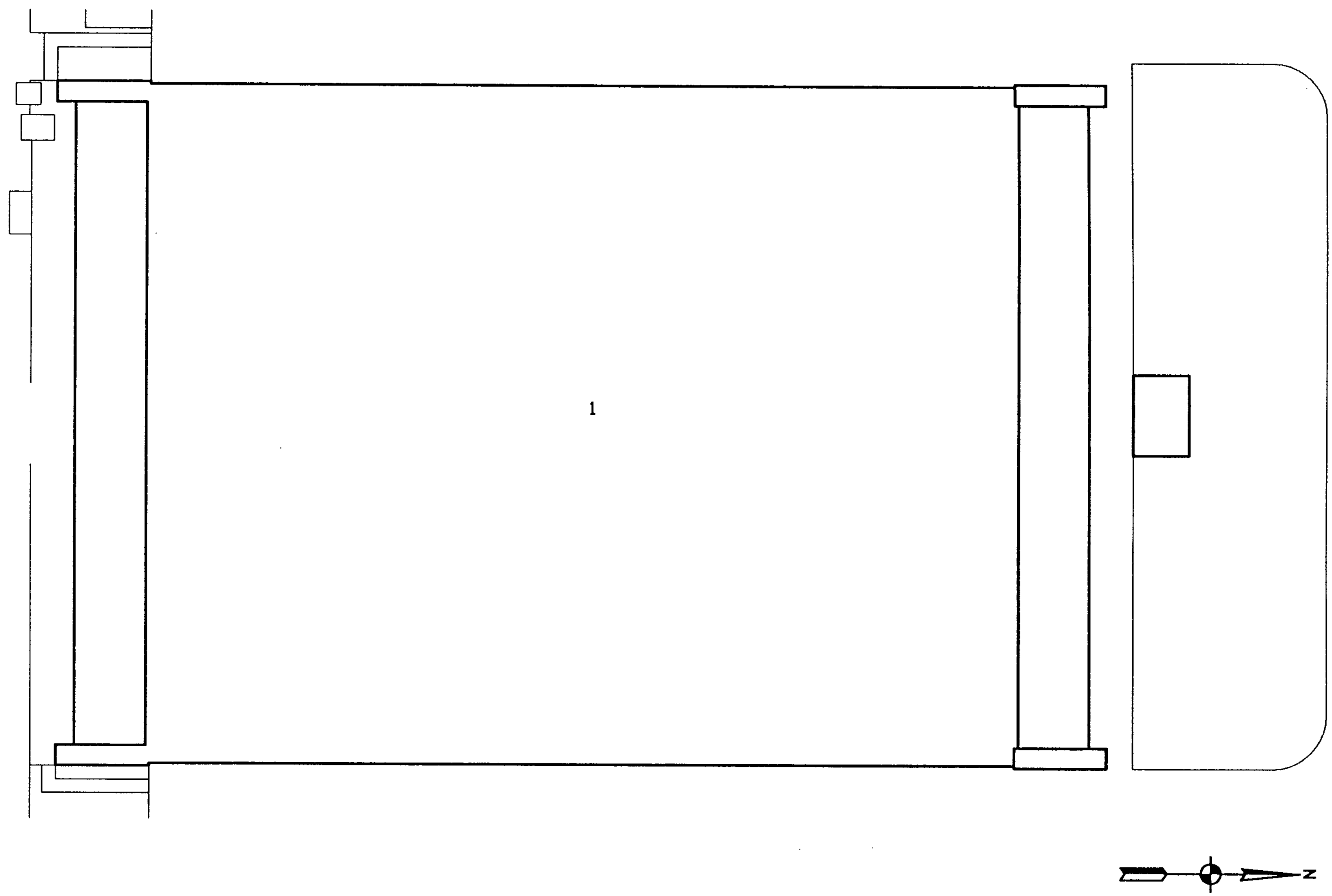


ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

HUITT ~ ZOLLARS
ENGINEERS/ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817)335-3000/METRO 429-1291

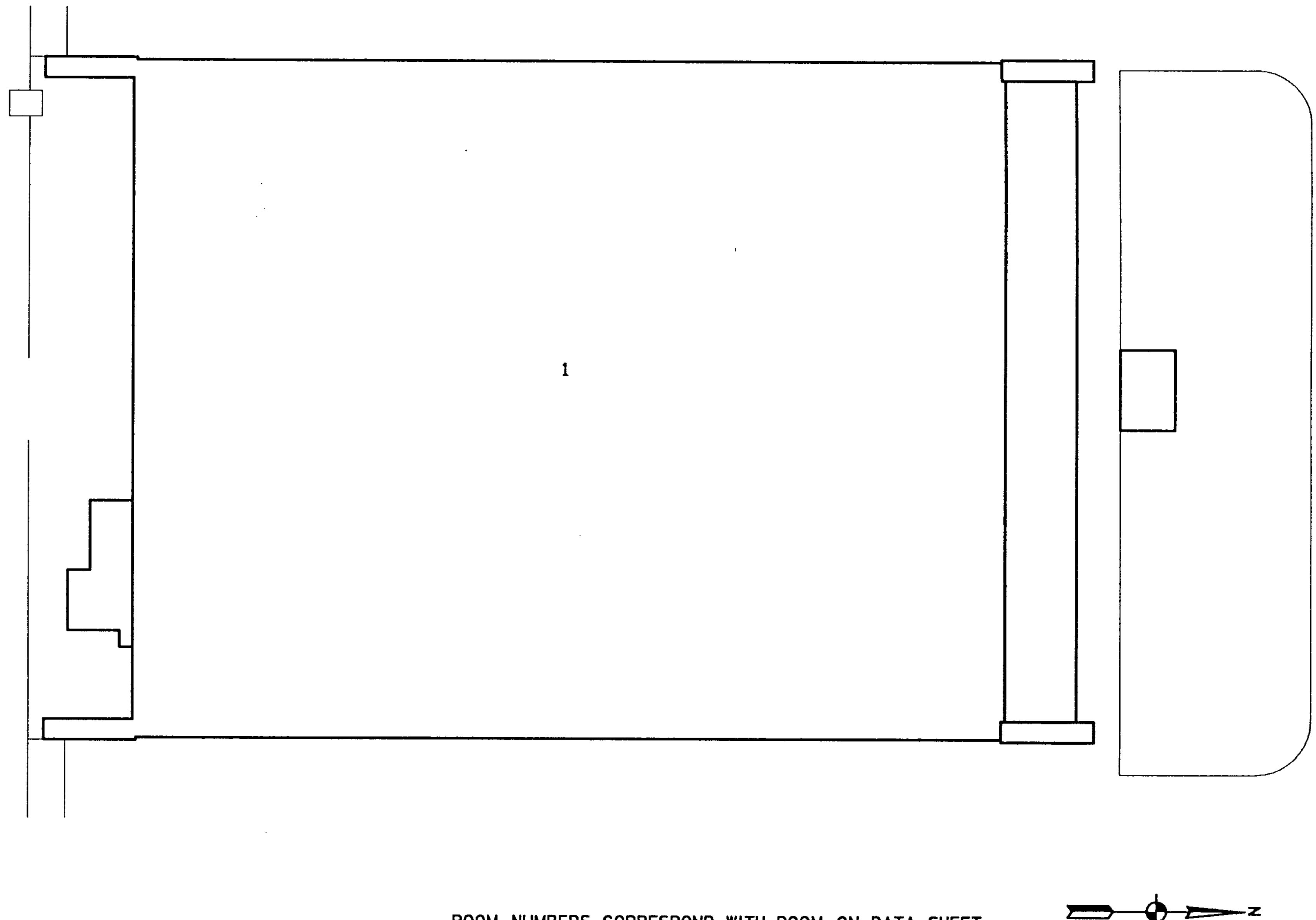
CORPUS CHRISTI
ARMY DEPOT

BUILDING 8
AREA "D"



ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

HUITT ~ ZOLLARS ENGINEERS/ARCHITECTS 512 MAIN STREET, SUITE 1500 FORT WORTH, TEXAS 76102-3922 (817)335-3000/METRO 429-1291	CORPUS CHRISTI ARMY DEPOT	HANGER 43



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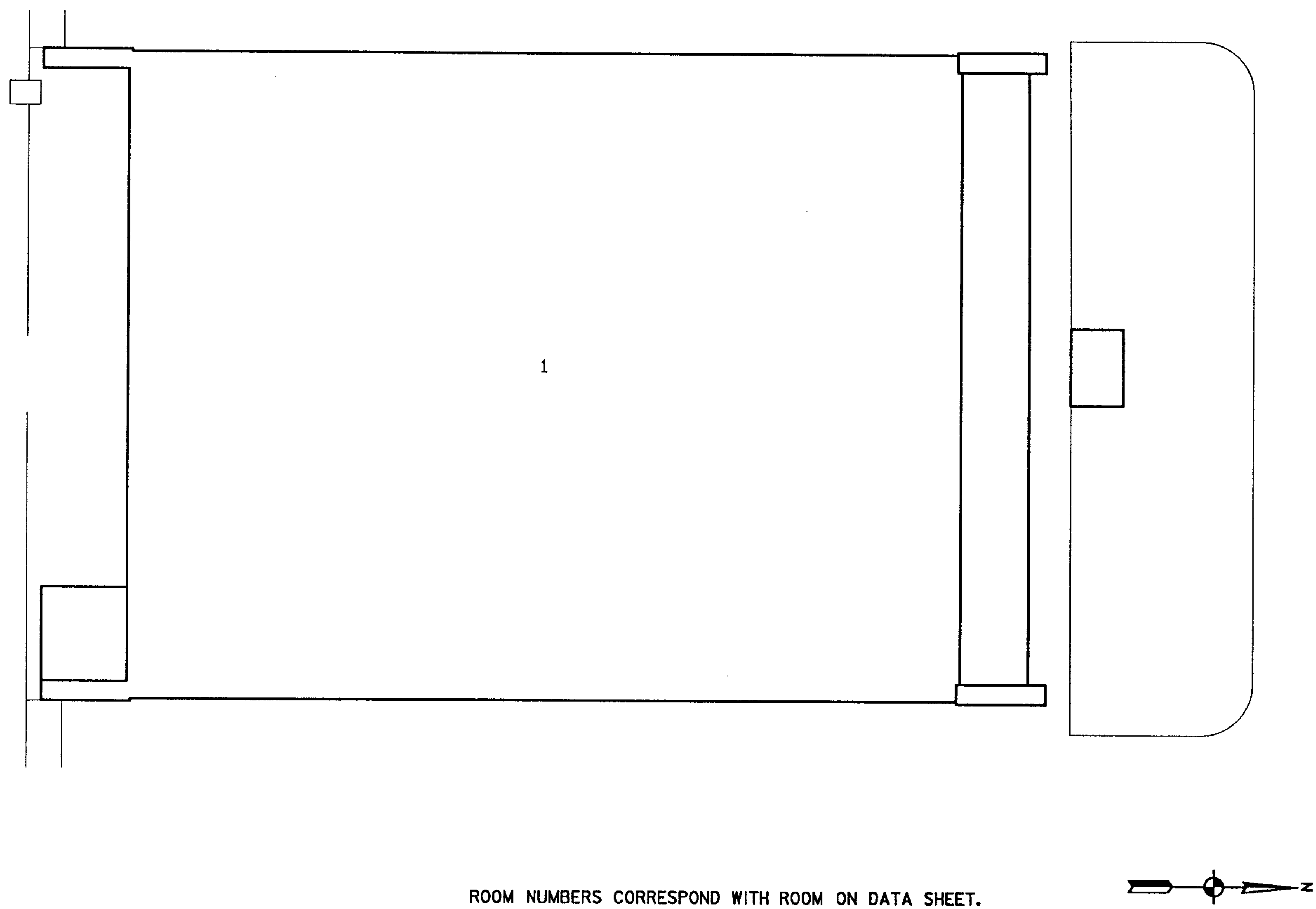
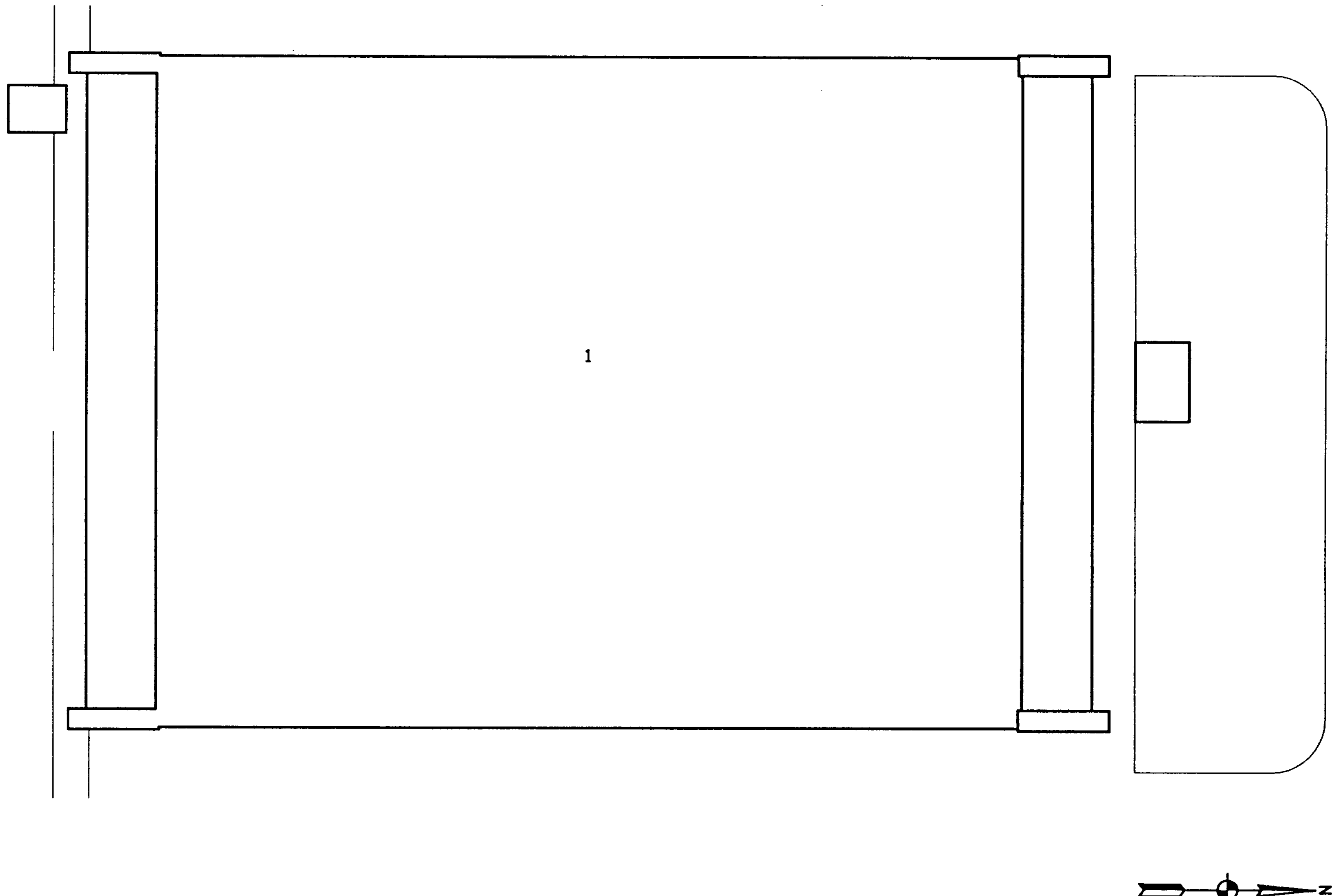
HUITT ~ ZOLLARS ENGINEERS/ARCHITECTS 512 MAIN STREET, SUITE 1500 FORT WORTH, TEXAS 76102-3922 (817)335-3000/METRO 429-1291	CORPUS CHRISTI ARMY DEPOT	HANGER 44



ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

HUITT ~ ZOLLARS ENGINEERS/ARCHITECTS 512 MAIN STREET, SUITE 1500 FORT WORTH, TEXAS 76102-3922 (817)335-3000/METRO 429-1291	CORPUS CHRISTI ARMY DEPOT	HANGER 45



ROOM NUMBERS CORRESPOND WITH ROOM ON DATA SHEET.

HUITT ~ ZOLLARS ENGINEERS/ARCHITECTS 512 MAIN STREET, SUITE 1500 FORT WORTH, TEXAS 76102-3922 (817)335-3000/METRO 429-1291	CORPUS CHRISTI ARMY DEPOT	HANGER 47

APPENDIX D

RECOMMENDED ECO CALCULATIONS

APPENDIX D
RECOMMENDED ECO CALCULATIONS

TABLE OF CONTENTS

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D-1
DATE:	4/4/95
ECO TITLE:	Provide Motion Sensor Controls For Lights
INSTALLATION:	Corpus Christi Army Depot, Building 8
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	76,789	KWH/yr
Total Energy Savings	262.08	MMBTU/yr
Total Cost Savings	5,779	$/yr
Total Investment	4,358	$
Simple Payback	0.7	yrs
SIR	20.44	

B. ECO Description:

Install 16 ceiling mounted motion sensors in various production storage areas of Building 8. Recircuit the 8' fluorescent light fixtures to allow the new sensors to turn off the lights during unoccupied periods. The sensors shall be the ceiling mounted type and shall generally cover 2,000 sqft of area in a 360° pattern. This ECO will require design of the lighting control system, installation of the sensors and recircuiting of the existing lights.

C. Discussion:

Some of the production areas of Building 8 are used for storage or maintenance shops and appear to be unoccupied large portions of the work day. These areas typically have 8' fluorescent lighting which is typically left on during these unoccupied periods.

Motion sensors should be installed on the ceilings of these areas to sense the unoccupied periods, turn off the lights and save the unneeded lighting energy. Since these areas have shelving and other partitions throughout, careful consideration should be given to the type of sensor to be used. It is conservatively estimated that 50% of the work day, these areas are unoccupied.

D. Savings Calculations: The energy savings calculations were performed in Figure D-1, using actual data obtained during the site survey. The following sample calculation demonstrates the procedure followed for each area:

Sample Calculation: Room #105, Building 8

(a) *Existing Annual Hours* (H_L): The annual period that the lighting is currently burned is determined as follows:

$$H_L = \frac{4\ days}{week} \times \frac{10\ hrs}{day} \times \frac{52\ wks}{yr} = 2{,}080\ \frac{hrs}{yr}$$

(b) *Annual Energy Savings* (ΔE):

$$\Delta E = Qty \ x \ L \ x \ W \ x \ 1.2 \ x \ H_L \ x \ \frac{P}{100} \ x \ \frac{1 \ KW}{1{,}000 \ W} \qquad \frac{KWH}{yr}$$

where,

L = number of lamps per fixture
P = unoccupied lighting savings percentage[1] = 50%
Qty = number of light fixtures in area
W = watts per lamp, watts
1.2 = fluorescent ballast factor

$$\Delta E = 105 \ x \ 2 \ x \ 75 \ x \ 1.2 \ x \ 2{,}080 \ x \ \frac{50}{100} \ x \ \frac{1 \ KW}{1{,}000 \ W} = 19{,}656 \ \frac{KWH}{yr}$$

Figure D-1. Energy Savings Calculations

ROOM NO.	ROOM FUNCTION	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	LAMP WATTS	FIXTURE DESCRIPTION	EXIST. ANNUAL HOURS	LIGHTING SAVINGS PERCENT %	ANNUAL ENERGY SAVINGS KWH/YR	NUMBER OF SENSORS REQD.
100	TEST DATA WAREHOUSE	18	2	110	PENDENT FLUOR.	2080	50	4,942	2
101	ASSEMBLY	58	2	110	PENDENT FLUOR.	2080	50	15,924	2
102	ASSEMBLY	28	2	75	PENDENT FLUOR.	2080	50	5,242	3
105	JOINER SHOP	105	2	75	PENDENT FLUOR.	2080	50	19,656	4
107	MAINTENANCE	56	2	110	PENDENT FLUOR.	2080	50	15,375	2
108	MAINTENANCE	7	2	110	PENDENT FLUOR.	2080	50	1,922	1
131	MANUFACTURING	25	2	110	PENDENT FLUOR.	2080	50	13,728	2
TOTALS		297						76,789	16

The total energy savings calculated from Figure D-1 are as follows:

$$\Delta E = \frac{76{,}789 \ KWH}{yr} \ x \ \frac{3{,}413 \ BTU}{KWH} \ x \ \frac{1 \ MMBTU}{1{,}000{,}000 \ BTU} = 262.08 \ \frac{MMBTU}{yr}$$

(c) *Maintenance Cost Savings* (ΔC_M): Because the annual number of lamp burn hours have been reduced by this ECO, the facility will require less lighting maintenance. The maintenance cost savings from this ECO are calculated as follows:

$$\Delta C_M = C_L \ x \ \frac{\Delta H}{L_L} \ x \ Q_L \qquad \frac{\$}{yr}$$

where,

C_L = relamping cost per lamp[2] = \$25/lamp
ΔH = lighting hours saved[3] = 1,040 hrs/yr
L_L = lamp rated life[4] = 12,000 hrs
Q_L = total quantity of lamps[5] = 594 lamps

$$\Delta C_M = 25 \ x \ \frac{1{,}040}{12{,}000} \ x \ 594 = 1{,}287 \ \frac{\$}{yr}$$

E. Cost Estimate

The total implementation costs for this ECO were estimated on page D-4.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page D-5. The results of the analysis are listed in the project summary on page D-1.

REFERENCES

1. Assumed unoccupied 50% of work day.

2. Reference maintenance supervisor, 1 hr per lamp at labor rate of \$23.50 per hour, plus lamp cost.

3. (2,080 hrs per year) x 50% saved = 1,040 hrs/yr

4. Reference page 303, IES Lighting Handbook, 1993, Figure 6-116.

5. (297 fixtures x 2 lamps per fixture) = 594 lamps

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY: PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-D-1, Provide Motion Sensor Controls For Lights

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Installation of motion sensor controls	16	ea	1.1	30.00	528	80.00	1,280	1,808
Installation of power packs	16	ea	1.0	30.00	480	30.00	480	960
SUBTOTAL					1,008		1,760	2,768
O & P @ 20%					202		352	415
SUBTOTAL					1,210		2,112	3,183
DESIGN @ Minimum								1,000
SUBTOTAL								4,183
SIOH @ 5.5%								175
TOTAL								$4,358

NOTE: These prices are based on Means Electrical Cost Data, 1994, page 216, items 0100 and 0200.

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LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-5
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 3183.			
B. SIOH	$ 175.			
C. DESIGN COST	$ 1000.			
D. TOTAL COST (1A+1B+1C)	$ 4358.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$	0.	
F. PUBLIC UTILITY COMPANY REBATE		$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)				$ 4358.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	262.	$ 4492.	15.61	$ 70121.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		262.	$ 4492.		$ 70121.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1287.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 18970.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 18970.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 5779.

5. SIMPLE PAYBACK PERIOD (1G/4) .75 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 89091.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 20.44
(IF < 1 PROJECT DOES NOT QUALIFY)

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D-2
DATE:	4/4/95
ECO TITLE:	Provide Daylighting Controls For Large Hangar
INSTALLATION:	Corpus Christi Army Depot, Large Hangar in Building 8
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	63,936	KWH/yr
Total Energy Savings	218.2	MMBTU/yr
Total Cost Savings	3,879	$/yr
Total Investment	10,393	$
Simple Payback	2.7	yrs
SIR	5.81	

B. ECO Description:

Install 4 photocell sensors and 1 relay panel in the large hangar of Building 8. Recircuit the 300 existing 400W HPS light fixtures to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. Relays will operate off of a signal from photocell sensors. The on/off setpoint of the relays shall be adjustable from the relay panel. This ECO will require design of the lighting control system, installation of the sensors and relay panel, and recircuiting of the existing lights.

C. Discussion:

The large hangar of Building 8 has large doors on the east and the west ends which nearly span the entire length of the hangar. During the normal work day, these doors are open, except for periods of inclimate weather. The open doors allow large amounts of daylight to enter the hangar. Lighting measurements taken during the survey indicated that with the lights turned off, acceptable levels were still maintained through daylighting. Task lighting in the work areas is currently used for specific tasks requiring light levels greater than the ambient level.

Photocell sensors should be installed in the hangar bays to sense these periods and turn off a portion of the lights to save the unneeded lighting energy. It is estimated that 25% of the lights left on during these periods, combined with the substantial daylighting, will allow an acceptable ambient light level within the hangar bays. These daylighting periods are estimated to be 4 hours per day for each side of the hangar. The multiple sensors and recircuiting will allow the east half of a hangar bay to be in the daylighting mode, while the west half is fully lighted and vice versa.

D. Savings Calculations:

(a) *Annual Daylighting Period* (P_D): The annual daylighting period is the number of weeks per year when the hangar doors are open and the weather permits acceptable levels of daylight to enter the hangar bays. For the purposes of this study, it is assumed that daylighting is not possible whenever the outside temperature is below 60 F because the building will be in the heating mode[1] with the doors closed.

$$P_D = \frac{H_{60}}{\left[24\ \frac{hrs}{day}\ x\ 7\ \frac{day}{week}\right]} \quad \frac{wks}{yr}$$

where,

H_{60} = annual hours above 60 F = 6,259 hrs/yr[2]

$$P_D = \frac{6{,}259}{[24\ x\ 7]} = 37\ \frac{wks}{yr}$$

(b) *Daylighting Load Savings* (KW) are the kilowatts of lights off during daylighting periods as follows:

$$KW = 300\ lights\ x \left(\frac{3}{4}\right) x\ \frac{480\ W}{light}\ x\ \frac{1\ KW}{1{,}000\ W} = 108.0\ KW$$

(c) *Annual Energy Savings* (ΔE):

$$\Delta E = KW\ x\ P_D\ x\ D\ x\ H_D \quad \frac{KWH}{yr}$$

where,

D = days per week of lighting usage = 4 day/wk
H_D = estimated period of daylighting available = 4 hrs/day

$$\Delta E = 108.0\ x\ 4\ x\ 4\ x\ 37 = 63{,}936\ \frac{KWH}{yr}$$

In units of BTUs, the energy savings are as follows:

$$\Delta E = \frac{63{,}936\ KWH}{yr}\ x\ \frac{3{,}413\ BTU}{KWH}\ x\ \frac{1\ MMBTU}{1{,}000{,}000\ BTU} = 218.2\ \frac{MMBTU}{yr}$$

(d) *Maintenance Cost Savings* (ΔC_M): Because the annual number of lamp burn hours have been reduced by this ECO, the facility will require less lighting maintenance. The maintenance cost savings from this ECO is calculated as follows:

$$\Delta C_M = C_L\ x\ \frac{\Delta H}{L_L}\ x\ Qty \quad \frac{\$}{yr}$$

where,

C_L = relamping cost per lamp[3] = \$25/lamp
H = annual daylighting hours[4] = 592 hrs/yr
L_L = existing lamp rated life[5] = 24,000 hrs
Qty = quantity of lamps off during daylighting[6] = 225 lamps

$$\Delta C_M = 25 \ x \ \frac{592}{24{,}000} \ x \ 225 = 139 \ \frac{\$}{yr}$$

E. Cost Estimate

The total implementation costs for this ECO were estimated on page D-9.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page D-10. The results of the analysis are listed in the project summary on page D-6.

REFERENCES

1. Reference Appendix page B-1, Heating Percentage Calculations.
2. Reference Appendix page B-1, Heating Percentage Calculations.
3. Reference maintenance supervisor, 1 hr per lamp at labor rate of $23.50 per hour, plus lamp cost.
4. (4 hrs per day) x (4 days per week) x (37 weeks per year) = 592 hours per year of daylighting.
5. Per IES lamp data for 400W HPS lamps.
6. (300 fixtures x 1 lamp per fixture) x (3/4 off during daylighting) = 225 lamps

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-D-2, Provide Daylighting Controls For Large Hangar

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install daylighting control panel, contactors, controller and sensors	1	ea	50.0	30.00	1,500	6,000.00	6,000	7,500
NOTE: This price is based on a budget estimate from the Edwin Jones Company, Dallas, Texas, 800-369-4010, dated 10/28/95.								
SUBTOTAL					1,500		6,000	7,500
O & P @ 20%					300		1,200	1,125
SUBTOTAL					1,800		7,200	8,625
DESIGN @ 15%								1,294
SUBTOTAL								9,919
SIOH @ 5.5%								474
TOTAL								$10,393

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-4
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 8625.		
B. SIOH	$ 474.		
C. DESIGN COST	$ 1294.		
D. TOTAL COST (1A+1B+1C)	$ 10393.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 10393.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	218.	$ 3740.	15.61	$ 58381.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		218.	$ 3740.		$ 58381.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 139.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2049.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 2049.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 3879.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.68 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 60429.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 5.81
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.59 %

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D-3
DATE:	4/4/95
ECO TITLE:	Provide Daylighting Controls For Repair Hangars
INSTALLATION:	Corpus Christi Army Depot, Hangars #43, 44, 45 and 47
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	226,759	KWH/yr
Total Energy Savings	773.3	MMBTU/yr
Total Cost Savings	13,757	$/yr
Total Investment	41,573	$
Simple Payback	3.0	yrs
SIR	5.16	

B. ECO Description:

Install 4 photocell sensors and 1 relay panel in each of hangars #43, 44, 45 and 47. Recircuit the 266 existing 400W HPS light fixtures in each hangar to allow the new relays to turn off 3/4 of the lights in each quadrant, while leaving 1/4 of the lights on. Relays will operate off of signal from photocell sensors. The on/off setpoint of the relays shall be adjustable from the relay panels. This ECO will require design of the lighting control systems, installation of the sensors and relay panels, and recircuiting of the existing lights.

C. Discussion:

The hangars #43, 44, 45 and 47 have large doors on the east and the west ends which nearly span the entire length of the building. During the normal work day, these doors are open, except for periods of inclimate weather. The open doors allow large amounts of daylight to enter the buildings. Lighting measurements taken during the survey indicated that with the lights turned off, acceptable light levels were still maintained through daylighting for large periods of the day. Task lighting in the work areas is currently used for specific tasks requiring light levels greater than the ambient level.

Photocell sensors should be installed in the hangar bays to sense these periods and turn off a portion of the lights to save the unneeded lighting energy. It is estimated that 25% of the lights left on during these periods, combined with the substantial daylighting, will allow an acceptable ambient light level within the hangar bays. These daylighting periods are estimated to be 4 hours per day for both ends of the hangars. The multiple sensors and recircuiting will allow the east end of a hangar bay to be in the daylighting mode, while the west end is fully lighted and vice versa.

D. Savings Calculations:

(a) *Annual Daylighting Period* (P_D): The annual daylighting period is the number of weeks per year when the hangar doors are open and the weather permits acceptable levels of daylight to enter the hangar bays. For the purposes of this study, it is assumed that daylighting is not possible whenever the outside temperature is below 60 F because the building will be in the heating mode[1].

$$P_D = \frac{H_{60}}{\left[24\ \frac{hrs}{day}\ x\ 7\ \frac{day}{week}\right]} \quad \frac{wks}{yr}$$

where,

H_{60} = annual hours above 60 F = 6,259 hrs/yr[2]

$$P_D = \frac{6{,}259}{[24\ x\ 7]} = 37\ \frac{wks}{yr}$$

(b) *Daylighting Load Savings* (KW) are the kilowatts of lights off during daylighting periods as follows:

$$KW = \frac{266\ lights}{hangar}\ x\ 4\ hangars\ x\ \left(\frac{3}{4}\right)\ x\ \frac{480\ W}{light}\ x\ \frac{1\ KW}{1{,}000\ W} = 383.04\ KW$$

(c) *Annual Energy Savings* (ΔE):

$$\Delta E = KW\ x\ P_D\ x\ D\ x\ H_D \quad \frac{KWH}{yr}$$

where,

D = days per week of lighting usage = 4 day/wk

H_D = estimated period of daylighting available = 4 hrs/day

$$\Delta E = 383.04\ x\ 4\ x\ 4\ x\ 37 = 226{,}759\ \frac{KWH}{yr}$$

In units of BTUs, the energy savings are as follows:

$$\Delta E = \frac{226{,}759\ KWH}{yr}\ x\ \frac{3{,}413\ BTU}{KWH}\ x\ \frac{1\ MMBTU}{1{,}000{,}000\ BTU} = 773.9\ \frac{MMBTU}{yr}$$

(d) *Maintenance Cost Savings* (ΔC_M): Because the annual number of lamp burn hours have been reduced by this ECO, the facility will require less lighting maintenance. The maintenance cost savings from this ECO is calculated as follows:

$$\Delta C_M = C_L\ x\ \frac{\Delta H}{L_L}\ x\ Qty \quad \frac{\$}{yr}$$

where,

C_L = relamping cost per lamp[3] = \$25/lamp
H = annual daylighting hours[4] = 592 hrs/yr
L_L = existing lamp rated life[5] = 24,000 hrs
Qty = quantity of lamps off during daylighting[6] = 798 lamps

$$\Delta C_M = 25 \; x \; \frac{592}{24{,}000} \; x \; 798 = 492 \; \frac{\$}{yr}$$

E. Cost Estimate

The total implementation costs for this ECO were estimated on page D-14.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page D-15. The results of the analysis are listed in the project summary on page D-11.

REFERENCES

1. Reference Appendix page B-1, Heating Percentage Calculations.

2. Reference Appendix page B-1, Heating Percentage Calculations.

3. Reference maintenance supervisor, 1 hr per lamp at labor rate of \$23.50 per hour, plus lamp cost.

4. (4 hrs per day) x (4 days per week) x (37 weeks per year) = 592 hours per year of daylighting.

5. Per IES lamp data for 400W HPS lamps.

6. (266 fixtures x 1 lamp per fixture) x (4 hangars) x (3/4 off during daylighting) = 798 lamps

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-D-3, Provide Daylighting Controls For Repair Hangars

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install daylighting control panel, contactors, controller and sensors	4	ea	50.0	30.00	6,000	6,000.00	24,000	30,000
NOTE: This price is based on a budget estimate from the Edwin Jones Company, Dallas, Texas, 800-369-4010, dated 10/28/95.								
				SUBTOTAL	6,000		24,000	30,000
				O & P @ 20%	1,200		4,800	4,500
				SUBTOTAL	7,200		28,800	34,500
				DESIGN @ 15%				5,175
				SUBTOTAL				39,675
				SIOH @ 5.5%				1,898
				TOTAL				$41,573

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-3
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 34500.		
B. SIOH	$ 1898.		
C. DESIGN COST	$ 5175.		
D. TOTAL COST (1A+1B+1C)	$ 41573.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 41573.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	774.	$ 13265.	15.61	$ 207061.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		774.	$ 13265.		$ 207061.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 492.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7252.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 7252.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 13757.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.02 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 214313.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 5.16
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.91 %

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D-4
DATE:	4/4/95
ECO TITLE:	Replace Pendent Mounted Fluorescent Lighting In Administrative Areas
INSTALLATION:	Corpus Christi Army Depot, Building 8
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	48,052	KWH/yr
Steam Energy Penalty	53.8	klb/yr
Total Energy Savings	115.7	MMBTU/yr
Total Cost Savings	3,147	$/yr
Total Investment	29,424	$
Simple Payback	9.3	yrs
SIR	1.66	

B. ECO Description:

Remove 180 existing pendent mounted, 4 lamp fluorescent light fixtures and replace them with 172 lay-in, 2 lamp, 2x4 fluorescent light fixtures with electronic ballasts and prismatic lenses. This should be done in the administrative areas of Building 8. Locate the new light fixtures over desks or other work tables as required to provide 50 fc at the work station in each room. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same.

C. Discussion:

Some of the administrative office areas in Building 8 have 4 lamp, pendent mounted fluorescent light fixtures. These fixtures typically have louvers on the bottom and apertures in the top of the enclosure for partial indirect lighting off of the ceiling. Because only about 30% of the light that hits the ceiling is reflected back down to the work plane, a good deal of light is wasted. The louvered bottoms trap light within the fixture, lowering it's efficiency.

These fixtures should be replaced with 2 lamp, 2x4 lay-in troffers with prismatic lenses. The offices generally have suspended ceilings which would easily accommodate the new fixtures. Because the new fixtures would direct all of the light down to the work plane, the number of lamps required to maintain design lighting levels would be reduced. The existing average light levels were measured and recorded on the data sheets, along with the number of fixtures in each room. Some of the rooms had average light levels that were somewhat above that recommended for their specific types of area.

The new lighting layout design should consider the design light levels recommended by the IES, and place the fixtures over desks, work tables or work stations. This will maintain recommended levels at the work stations while not overlighting the surrounding work areas.

D. Savings Calculations:

In order to estimate the energy savings and implementation cost for this ECO, the number of new light fixtures to be installed in each space must be determined. This calculation requires the determination of several factors for each type of light fixture, as well as the existing and recommended light levels for each room.

(a) Room Cavity Ratio (RCR):

$$RCR = \frac{5\ x\ h_c\ x\ (L + W)}{(L\ x\ W)}$$

where,

h_c = height of fixture above work plane
L = room length
W = room width

Assumptions:

h_c = 6', distance from desk top to bottom of lights
L = 10'
W = 10'

$$RCR = \frac{5\ x\ (6)\ x\ (10 + 10)}{(10\ x\ 10)} = 6$$

(b) Coefficient of Utilization (CU):

Assumptions:

p_w = wall reflectivity = 30%
p_c = ceiling reflectivity = 30%
RCR = 6

From fixture data tables:

For existing fixture[1]: CU = 0.22
For new fixture[2]: CU = 0.34

(c) Luminaire Dirt Depreciation (LDD):

Assumptions:

[3] Existing fixture Class = II
[4] New fixture Class = VI
[5] Dirt conditions = Clean

From charts:

For existing fixture[6]: LDD = 0.94
For new fixture[7]: LDD = 0.86

(d) Lamp Data:

[8] From charts for existing F34T12:
Initial Lumens = 2800
Life = 20,000 hrs

[9] From charts for new F32T8:
Initial Lumens = 2850
Life = 20,000 hrs

With the above factors determined, the number of new light fixtures to be installed and the energy savings for each room were calculated in Figure D-4, see page 20. The following sample calculation demonstrates the procedure followed for each room.

Sample Calculation: Room #5, Building 8

(a) New fixture quantity:

$$Q_N = Q_E \ x \ \frac{fc_D \ (N \ x \ L \ x \ CU \ x \ LDD)_{exist}}{fc_E \ (N \ x \ L \ x \ CU \ x \ LDD)_{new}}$$

where,

CU = coefficient of utilization
fc_D = design footcandles
fc_E = existing footcandles
L = lamp initial lumens
LDD = lamp dirt depreciation factor
N = number of lamps in fixture
Q_E = existing quantity of fixtures in room
Q_N = new quantity of fixtures in room

$$Q_N = 4 \ x \ \frac{30 \ (4 \ x \ 2800 \ x \ .22 \ x \ .94)}{50 \ (2 \ x \ 2850 \ x \ .34 \ x \ .86)} = 3$$

(b) Lighting Energy Savings (ΔE_L):

$$\Delta E_L = H \ [(watts \ x \ qty)_{exist} - (watts \ x \ qty)_{new}] \left(\frac{1 \ KW}{1{,}000 \ watts}\right) \quad \frac{KWH}{yr}$$

where,

H = annual hours of lighting = 2,080 hrs/yr
qty = total quantity of fixtures in room
watts = total watts per fixture

Assumptions:

$watts_{exist}$ = (82 W per ballast x 2 ballasts per fixture) = 164 W
$watts_{new}$ = (62 W per ballast x 1 ballasts per fixture) = 62 W

$$\Delta E_L = 2{,}080\ [(164\ x\ 4) - (62\ x\ 3)] \left(\frac{1}{1{,}000}\right) = 978\ \frac{KWH}{yr}$$

(c) Cooling Energy Savings (ΔE_C):

$$\Delta E_C = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_C}{\left(EER\ x\ \frac{1{,}000\ watts}{KW}\right)} \quad \frac{KWH}{yr}$$

where,

EER[10] = cooling system efficiency = 10 BTU/W-hr
H_C[11] = percentage of year in cooling operation = 0.61

$$\Delta E_C = \frac{978\ (3{,}413)\ 0.61}{(10\ x\ 1{,}000)} = 204\ \frac{KWH}{yr}$$

(d) Heating Energy Penalty (ΔE_H):

$$\Delta E_H = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_H}{EFF_H\ x\ h_{fg}} \quad \frac{lbs}{yr}$$

where,

EFF[12] = heating system efficiency = 0.73
H_H[13] = percentage of year in heating operation = 0.26
h_{fg} = latent heat of 70 psig saturated steam = 898 BTU/lb

$$\Delta E_H = \frac{978\ (3413)\ 0.26}{(0.73\ x\ 898)} = 1{,}324\ \frac{lbs}{yr}$$

Figure D-4. Energy Savings Calculations

ROOM NO.	DESIGN ROOM FC	ACTUAL ROOM FC	EXIST. FIXTURE QTY.	EXIST. FIXTURE WATTS	EXIST. ANNUAL HOURS	NEW FIXTURE QTY.	NEW FIXTURE WATTS	LIGHTING ENERGY SAVINGS KWH/YR	COOLING ENERGY SAVINGS KWH/YR	HEATING ENERGY PENALTY LBS/YR
3	30	50	6	164	2080	5	62	1,402	292	1,898
4	30	50	4	164	2080	3	62	978	204	1,324
5	30	50	4	164	2080	3	62	978	204	1,324
6	30	50	4	164	2080	3	62	978	204	1,324
7	30	50	4	164	2080	3	62	978	204	1,324
11	30	90	3	164	2080	1	62	894	186	1,210
12	30	70	6	164	2080	4	62	1,531	319	2,072
13	30	70	6	164	2080	4	62	1,531	319	2,072
14	30	55	2	164	2080	2	62	424	88	574
22	30	83	6	164	2080	3	62	1,660	346	2,247
23	30	50	4	164	2080	3	62	978	204	1,324
25	30	50	3	164	2080	3	62	636	132	861
26	30	65	4	164	2080	3	62	978	204	1,324
27	30	60	8	164	2080	6	62	1,955	407	2,646
31	30	75	12	164	2080	7	62	3,191	664	4,320
45	30	35	1	164	8736	1	62	891	185	1,206
46	30	30	1	164	2080	1	62	212	44	287
47	30	45	2	164	2080	2	62	424	88	574
49	30	45	2	164	2080	2	62	424	88	574
95	50	60	96	164	2080	111	62	18,433	3,838	24,952
96	30	25	2	164	2080	3	62	295	61	399
TOTALS:			180			173		39,771	8,281	53,836

Using the total lighting and cooling energy savings calculated from Figure D-1, the total Electrical Energy Savings (ΔQ_{TE}) are determined as follows:

$$\Delta Q_{TE} = \left[(\Delta E_L + \Delta E_C) \ x \ \frac{3{,}413 \ BTU}{KWH} \right] x \ \frac{1 \ MMBTU}{1{,}000{,}000 \ BTU}$$

$$\Delta Q_{TE} = [(39{,}771 + 8{,}281) \; x \; 3{,}413] \; x \; \frac{1}{1{,}000{,}000} = 164.0 \; \frac{MMBTU}{yr}$$

The total Heating Energy Penalty (ΔQ_H) from Figure D-4 is as follows:

$$\Delta Q_H = 53{,}836 \frac{lbs}{yr} \; x \; 898 \; \frac{BTU}{lb} \; x \; \frac{1 \; MMBTU}{1{,}000{,}000 \; BTU} = 48.3 \; \frac{MMBTU}{yr}$$

Because the total number of lamps and ballasts have been reduced by this ECO, the facility will require less lighting maintenance. The Maintenance Cost Savings (ΔC_M) from this ECO is calculated as follows:

$$\Delta C_M = C_L \; x \; \frac{H}{L_L} \; x \; \Delta L$$

where,

C_L = relamping cost per lamp[14] = \$25/lamp
H = annual lighting hours[15] = 2,080 hrs/yr
L_L = rated lamp life = 20,000 hrs
ΔL = quantity of lamps removed[16] = 374

$$\Delta C_M = 25 \; x \; \frac{2{,}080}{20{,}000} \; x \; 374 = 972 \; \frac{\$}{yr}$$

E. Cost Estimate:

The total ECO implementation cost was estimated on page D-23.

F. Life Cycle Cost Estimate:

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page D-24. The results of the analysis are listed in the project summary on page D-16.

REFERENCES

1. Reference page 434, IES Lighting Handbook, 1993, fixture #29, (CU x 0.95) for 4 lamp fixture.

2. Reference page 438, IES Lighting Handbook, 1993, fixture #42, (CU x 1.07) for 32W lamps.

3. Reference page 396, IES Lighting Handbook, 1993, Figure 9-9.

4. Reference page 396, IES Lighting Handbook, 1993, Figure 9-9.

5. Reference page 397, IES Lighting Handbook, 1993, Figure 9-11.

6. Reference page 398, IES Lighting Handbook, 1993, Figure 9-12.

7. Reference page 398, IES Lighting Handbook, 1993, Figure 9-12.

8. Reference page 300, IES Lighting Handbook, 1993, Figure 6-115.

9. Reference page 300, IES Lighting Handbook, 1993, Figure 6-115.

10. Reference Appendix page B-1 for cooling system efficiency calculation.

11. Reference Appendix page B-1 for cooling period calculation.

12. Reference Appendix page B-1 for heating system efficiency calculation.

13. Reference Appendix page B-1 for heating period calculation.

14. Reference maintenance supervisor, 1 hr per lamp at labor rate of $23.50 per hour, plus lamp cost.

15. Reference Appendix page B-2.

16. (180 fixtures x 4 lamps) - (173 fixtures x 2 lamps) = 374 lamps removed.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-D-4, Replace Pendent Mounted Fluorescent Lighting In Administrative Areas

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing pendent fluorescent light fixtures	180	ea	0.3	30.00	1,620			1,620
Miscellaneous conduit, wire and recircuiting	172	ea	1.0	30.00	5,160	5.00	860	6,020
Installation of new two lamp, lay-in fluorescents with T8 lamps	172	ea	0.3	30.00	1,548	80.00	13,760	15,308
SUBTOTAL					8,328		14,620	22,948
O & P @ 20%					1,666		2,924	3,442
SUBTOTAL					9,994		17,544	26,390
DESIGN @ 6%								1,583
SUBTOTAL								27,973
SIOH @ 5.5%								1,451
TOTAL								$29,424

NOTE: These labor estimates here are based on experience with electrical contractors. The material costs are taken from the Energy Efficient Lighting Handbook, 1-800-DLA-BULB.

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 26390.		
B. SIOH	$ 1451.		
C. DESIGN COST	$ 1583.		
D. TOTAL COST (1A+1B+1C)	$ 29424.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 29424.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	164.	$ 2811.	15.61	$ 43879.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
L. OTHER	$ 13.16	-48.	$ -636.	14.74	$ -9369.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		116.	$ 2175.		$ 34510.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 972.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 14327.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 14327.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 3147.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.35 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 48837.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.66
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.75 %

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D-5
DATE:	4/4/95
ECO TITLE:	Replace Fluorescent Lighting In Production Areas
INSTALLATION:	Corpus Christi Army Depot, Building 8
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	686,616	KWH/yr
Steam Energy Penalty	830.7	klb/yr
Total Energy Savings	1597.5	MMBTU/yr
Total Cost Savings	54,131	$/yr
Total Investment	477,286	$
Simple Payback	8.8	yrs
SIR	1.74	

B. ECO Description:

Remove 3,017 existing pendent mounted, 2 lamp fluorescent light fixtures and replace them with 1,092 low-bay, 400 watt HPS light fixtures with rectangular pattern reflectors and lenses. This should be done in the production and warehouse areas of Building 8. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same, as much as is possible.

C. Discussion:

Most of the production areas in Building 8 have 2 lamp, pendent mounted fluorescent light fixtures. These fixtures typically have apertures in the top of the enclosure for partial indirect lighting off of the ceiling. Because only about 30% of the light that hits the ceiling is reflected back down to the work plane, a good deal of light is wasted. Because of the high mounting height, 110 watt high-output lamps are required to produce acceptable lighting levels.

These fixtures should be replaced with 400W HPS, low-bay light fixtures with rectangular pattern reflectors and lenses. The production areas generally have open beam ceilings which would easily accommodate the new fixtures. Because the new fixtures would direct all of the light down to the work plane, and because they produce a greater amount of light, less fixtures would be required to maintain design lighting levels. The existing average light levels were measured and recorded on the data sheets, along with the number of fixtures in each area.

The new lighting layout design should consider the design lighting levels recommended by the IES, and provide additional task lighting as required over work tables or work stations. This will maintain recommended levels at the work stations while not overlighting the surrounding work areas.

D. Savings Calculations:

In order to estimate the energy savings and implementation cost for this ECO, the number of new light fixtures to be installed in each space must be determined. This calculation requires the determination of several factors for each type of light fixture, as well as the existing and recommended light levels for each room.

(a) Room Cavity Ratio (RCR):

$$RCR = \frac{5 \; x \; h_c \; x \; (L + W)}{(L \; x \; W)}$$

where,

h_c = height of fixture above work plane
L = room length
W = room width

Assumptions:

h_c = 11', distance from work plane to bottom of lights
L = 20'
W = 20'

$$RCR = \frac{5 \; x \; (11) \; x \; (20 + 20)}{(20 \; x \; 20)} = 5.5$$

(b) Coefficient of Utilization (CU):

Assumptions:

p_w = wall reflectivity = 30%
p_c = ceiling reflectivity = 30%
RCR = 5.5

From fixture data tables:

For existing fixture[1]: CU = 0.37
For new fixture[2]: CU = 0.35

(c) Luminaire Dirt Depreciation (LDD):

Assumptions:

[3] Existing fixture Class = II
[4] New fixture Class = VI
[5] Dirt conditions = Dirty

From charts:

For existing fixture[6]: LDD = 0.86
For new fixture[7]: LDD = 0.75

(d) Lamp Data:

[8] From charts for existing F96T12/HO:

Initial Lumens = 8,830
Life = 12,000 hrs
Lumen Depreciation = 0.77
Watts = 110

[9] From charts for new LU400/BU:

Initial Lumens = 50,000
Life = 24,000 hrs
Lumen Depreciation = 0.84
Watts = 400

With the above factors determined, the number of new light fixtures to be installed and the energy savings for each room were calculated in Figure D-5, see page D-29. The following sample calculation demonstrates the procedure followed for each room.

Sample Calculation: Room #114, Building 8

(a) New fixture quantity:

$$Q_N = Q_E \ x \ \frac{fc_D \ (N \ x \ L \ x \ CU \ x \ LDD \ x \ LLD)_{exist}}{fc_E \ (N \ x \ L \ x \ CU \ x \ LDD \ x \ LLD)_{new}}$$

where,

CU = coefficient of utilization
fc_D = design footcandles
fc_E = existing footcandles
L = lamp initial lumens
LDD = lamp dirt depreciation factor
LLD = lamp lumen depreciation factor
N = number of lamps in fixture
Q_E = existing quantity of fixtures in room
Q_N = new quantity of fixtures in room

$$Q_N = 202 \ x \ \frac{50 \ (2 \ x \ 8{,}830 \ x \ .37 \ x \ .87 \ x \ .77)}{60 \ (1 \ x \ 50{,}000 \ x \ .35 \ x \ .75 \ x \ .84)} = 66$$

(b) Lighting Energy Savings (ΔE_L):

$$\Delta E_L = H \ [(watts \ x \ qty)_{exist} - (watts \ x \ qty)_{new}] \left(\frac{1 \ KW}{1{,}000 \ watts}\right) \quad \frac{KWH}{yr}$$

where,

H = annual hours of lighting = 2,080 hrs/yr
qty = total quantity of fixtures in room
watts = total watts per fixture

Assumptions:

$watts_{exist}$ = (264 W per ballast x 1 ballasts per fixture) = 264 W
$watts_{new}$ = (480 W per ballast x 1 ballasts per fixture) = 480 W

$$\Delta E_L = 2{,}080 \ [(264 \ x \ 202) - (480 \ x \ 66)] \left(\frac{1}{1{,}000}\right) = 45{,}028 \ \frac{KWH}{yr}$$

(c) Cooling Energy Savings (ΔE_C):

$$\Delta E_C = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_C}{\left(EER\ x\ \frac{1{,}000\ watts}{KW}\right)} \quad \frac{KWH}{yr}$$

where,

EER[10] = cooling system efficiency = 10 BTU/W-hr
H_C[11] = percentage of year in cooling operation = 0.61

$$\Delta E_C = \frac{45{,}028\ (3{,}413)\ 0.61}{(10\ x\ 1{,}000)} = 9{,}374\ \frac{KWH}{yr}$$

(d) Heating Energy Penalty (ΔE_H):

$$\Delta E_H = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_H}{EFF_H\ x\ h_{fg}} \quad \frac{lbs}{yr}$$

where,

EFF[12] = heating system efficiency = 0.73
H_H[13] = percentage of year in heating operation = 0.26
h_{fg} = latent heat of 70 psig saturated steam = 898 BTU/lb

$$\Delta E_H = \frac{45{,}028\ (3413)\ 0.26}{(0.73\ x\ 898)} = 60{,}953\ \frac{lbs}{yr}$$

Figure D-5. Energy Savings Calculations

ROOM NO.	DESIGN ROOM FC	ACTUAL ROOM FC	EXIST. FIXTURE QTY.	EXIST. FIXTURE WATTS	EXIST. ANNUAL HOURS	NEW FIXTURE QTY.	NEW FIXTURE WATTS	LIGHTING ENERGY SAVINGS KWH/YR	COOLING ENERGY SAVINGS KWH/YR	HEATING ENERGY PENALTY LBS/YR
103	10	15	16	396	2080	4	480	9,185	0	12,433
106	50	50	11	264	2080	4	480	2,047	0	2,771
109	75	100	18	264	2080	5	480	4,892	1,018	6,622
110	50	50	4	264	2080	2	480	200	42	271
111	45	45	72	264	2080	28	480	11,581	0	15,677
112	45	45	54	264	2080	21	480	8,686	0	11,758
113	45	45	16	264	2080	6	480	2,796	0	3,785
114	50	60	202	264	2080	66	480	45,028	9,375	60,953
115	50	50	115	264	2080	45	480	18,221	0	24,665
116	50	50	96	264	2080	38	480	14,776	0	20,002
117	30	30	75	264	2080	29	480	12,230	0	16,555
118	20	20	30	264	2080	12	480	4,493	0	6,082
119	50	50	153	264	2080	60	480	24,111	5,020	32,638
120	50	50	187	264	2080	73	480	29,802	6,205	40,342
121	50	60	115	264	2080	38	480	25,210	0	34,126
122	50	70	48	264	8736	13	480	56,190	0	76,062
123	10	10	80	264	2080	31	480	12,979	0	17,569
124	50	60	65	264	2080	21	480	14,726	3,066	19,934
125	40	40	65	264	2080	26	480	9,734	2,027	13,177
127	50	62	68	264	2080	22	480	15,375	3,201	20,813
128	50	50	85	264	2080	33	480	13,728	2,858	18,583
129	50	60	140	264	2080	46	480	30,950	6,444	41,896
130	35	35	45	264	2080	18	480	6,739	1,403	9,122
131	30	30	25	264	2080	10	480	3,744	0	5,068
132	30	30	55	264	2080	22	480	8,237	0	11,150
134	20	20	155	264	2080	61	480	24,211	0	32,774
136	30	30	204	264	2080	80	480	32,148	6,693	43,518
137	50	65	148	264	2080	45	480	36,342	0	49,195
138	75	90	240	264	2080	78	480	53,914	11,225	72,981
139	10	12	55	264	2080	18	480	12,230	0	16,555
142	40	40	230	264	2080	90	480	36,442	7,587	49,330
143	50	60	145	264	2080	47	480	32,698	6,807	44,262
TOTALS:			3,017			1,092		613,645	72,971	830,669

Using the total lighting and cooling energy savings calculated from Figure D-5, the total Electrical Energy Savings (ΔQ_{TE}) are determined as follows:

$$\Delta Q_{TE} = \left[(\Delta E_L + \Delta E_C)\ x\ \frac{3{,}413\ BTU}{KWH}\right]\ x\ \frac{1\ MMBTU}{1{,}000{,}000\ BTU}$$

$$\Delta Q_{TE} = [(613{,}645 + 72{,}971)\ x\ 3{,}413]\ x\ \frac{1}{1{,}000{,}000} = 2{,}343.4\ \frac{MMBTU}{yr}$$

The total Heating Energy Penalty (ΔQ_H) from the spreadsheet is as follows:

$$\Delta Q_H = 830{,}669\frac{lbs}{yr}\ x\ 898\ \frac{BTU}{lb}\ x\ \frac{1\ MMBTU}{1{,}000{,}000\ BTU} = 745.9\ \frac{MMBTU}{yr}$$

Because the total number of lamps and ballasts have been reduced by this ECO, the facility will require less lighting maintenance. The Maintenance Cost Savings (ΔC_M) from this ECO is calculated as follows:

$$\Delta C_M = C_L\ x\ H\ x\left[\frac{Q_E}{L_E} - \frac{Q_N}{L_N}\right]$$

where,

C_L = relamping cost per lamp[14] = \$25/lamp
H = annual lighting hours[15] = 2,080 hrs/yr
L_E = existing lamp rated life = 12,000 hrs
L_N = new lamp rated life = 20,000 hrs
Q_E = existing quantity of lamps[16] = 6,034
Q_N = new quantity of lamps[17] = 1,092

$$\Delta C_M = (25)\ x\ 2{,}080\ x\left[\frac{6{,}034}{12{,}000} - \frac{1{,}092}{24{,}000}\right] = 23{,}781\ \frac{\$}{yr}$$

E. Cost Estimate

The implementation cost for this ECO is calculated on page D-32.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page D-33. The results of the analysis are listed in the project summary on page D-25.

REFERENCES

1. Reference page 434, IES Lighting Handbook, 1993, fixture #25.

2. Reference page 432, IES Lighting Handbook, 1993, fixture #21.

3. Reference page 396, IES Lighting Handbook, 1993, Figure 9-9.

4. Reference page 396, IES Lighting Handbook, 1993, Figure 9-9.

5. Reference page 397, IES Lighting Handbook, 1993, Figure 9-11.

6. Reference page 398, IES Lighting Handbook, 1993, Figure 9-12.

7. Reference page 398, IES Lighting Handbook, 1993, Figure 9-12.

8. Reference page 303, IES Lighting Handbook, 1993, Figure 6-116.

9. Reference page 313, IES Lighting Handbook, 1993, Figure 6-122.

10. Reference Appendix page B-1 for cooling system efficiency calculation.

11. Reference Appendix page B-1 for cooling period calculation.

12. Reference Appendix page B-1 for heating system efficiency calculation.

13. Reference Appendix page B-1 for heating period calculation.

14. Reference maintenance supervisor, 1 hr per lamp at labor rate of $23.50 per hour, plus lamp cost.

15. Reference Appendix page B-2.

16. (3,017 fixtures x 2 lamps per fixture) = 6,034 lamps

17. (1,092 fixtures x 1 lamp per fixture) = 1,092 lamps

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-D-5, Replace Fluorescent Lighting In Production Areas

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing pendent fluorescent light fixtures	3,017	ea	0.3	30.00	27,153			27,153
Miscellaneous conduit, wire and recircuiting	1,092	ea	1.0	30.00	32,760	5.00	5,460	38,220
Installation of new 400W HPS light fixtures	1,092	ea	0.3	30.00	9,828	272.00	297,024	306,852
				SUBTOTAL	69,741		302,484	372,225
				O & P @ 20%	13,948		60,497	55,834
				SUBTOTAL	83,689		362,981	428,059
				DESIGN @ 6%				25,684
				SUBTOTAL				453,743
				SIOH @ 5.5%				23,543
				TOTAL				$477,286

NOTE: These labor estimates here are based on experience with electrical contractors. The material costs are taken from a budget estimate from Texas Lighting Sales, Michelle, 11/7/94, 817-283-8300.

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-2
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 428059.		
B. SIOH	$ 23543.		
C. DESIGN COST	$ 25684.		
D. TOTAL COST (1A+1B+1C)	$ 477286.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 477286.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	2343.	$ 40166.	15.61	$ 626989.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
L. OTHER	$ 13.16	-746.	$ -9816.	14.74	$ -144688.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		1597.	$ 30350.		$ 482301.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 23781.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 350532.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 350532.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 54131.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.82 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 832833.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.74
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.01 %

APPENDIX E

NON-RECOMMENDED ECO CALCULATIONS

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	E-1
DATE:	4/4/95
ECO TITLE:	Install Electronic Ballasts and Energy Savings Fluorescent Lamps
INSTALLATION:	Corpus Christi Army Depot, Building 8
LOCATION:	Corpus Christi, Texas

A. Summary:

Electrical Energy Savings	409,466	KWH/yr
Steam Energy Penalty	478.9	klb/yr
Total Energy Savings	1,397.5	MMBTU/yr
Total Cost Savings	17,651	$/yr
Total Investment	407,015	$
Simple Payback	23.0	yrs
SIR	0.69	

B. ECO Description:

Remove all of the existing magnetic ballasts and the T12 lamps from pendent mounted fluorescent light fixtures and install new electronic ballasts and T8 lamps. This will require the replacement of existing lamp sockets with new sockets designed for the T8 lamps. The existing F34T12 lamps (34 watts) should be replaced with F32T8 lamps (32 watts), and the existing F96T12 lamps (75 watts) with F96T8 lamps (59 watts). The existing F96T12HO lamps (110 watts) should remain because the higher lumen output of the lamp is required in the areas where they are used. There are a total of 3,851 ballasts to be retrofitted, and 7,702 lamps to be retrofitted. This ECO will require a design specification of the new equipment and scope of work, as well as the replacement of fluorescent ballasts and lamps.

C. Discussion:

The existing pendent mounted fluorescent fixtures in the production areas and office areas currently use 34 watt energy saving lamps in the 4' fixtures, and either 75 watt or 110 watt lamps in the 8' fixtures. All of these are T12 lamps. The newer technology T8 lamps can produce an equivalent or higher lumen output, with a lower power input. Also, all of these fixtures have standard magnetic ballasts. The new technology electronic ballasts operate on a higher frequency than the magnetic type, and are therefore more efficient, requiring less input power.

D. Savings Calculations: The room by room energy savings calculations were performed in Figure E-1, using information collected on the data sheets. The following sample calculation demonstrates the procedure followed for each room.

Sample Calculation:

From data sheet:

Room #5
No. of fixtures = 4
lamps per fixture = 4
existing lamp wattage = 34W
annual hours of lighting = 2,080 hrs/yr

Assumptions:

existing ballast input[1] = 82 W
new ballast input[2] = 62 W

(a) Existing Annual Lighting Energy:

$$L_E = 2{,}080\ \frac{hrs}{yr}\left[\frac{82\ watts}{ballast}\ x\ \frac{2\ ballasts}{fixture}\ x\ 4\ fixtures\right]\left(\frac{1\ KW}{1{,}000\ watts}\right) = 1{,}364\ \frac{KWH}{yr}$$

(b) New Annual Lighting Energy:

$$L_N = 2{,}080\ \frac{hrs}{yr}\left[\frac{62\ watts}{ballast}\ x\ \frac{2\ ballasts}{fixture}\ x\ 4\ fixtures\right]\left(\frac{1\ KW}{1{,}000\ watts}\right) = 1{,}032\ \frac{KWH}{yr}$$

(c) Lighting Energy Savings (ΔE_L):

$$\Delta E_L = (1{,}364-1{,}032)\ \frac{KWH}{yr} = 332\ \frac{KWH}{yr}$$

(d) Cooling Energy Savings (ΔE_C):

$$\Delta E_C = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_C}{\left(EER\ x\ \frac{1{,}000\ watts}{KW}\right)} \quad \frac{KWH}{yr}$$

where,

EER[3] = cooling system efficiency = 10 BTU/W-hr
H_C[4] = percentage of year in cooling operation = 0.52

$$\Delta E_C = \frac{332\ (3{,}413)\ 0.52}{(10\ x\ 1{,}000)} = 59\ \frac{KWH}{yr}$$

(d) Heating Energy Penalty (ΔE_H):

$$\Delta E_H = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_H}{EFF_H\ x\ h_{fg}} \quad \frac{lbs}{yr}$$

where,

EFF[5] = heating system efficiency = 0.73
H_H[6] = percentage of year in heating operation = 0.28
h_{fg} = latent heat of 70 psig saturated steam = 898 BTU/lb

Figure E-1. Energy Savings Calculations

ROOM NO.	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	BALLAST PER FIXTURE	EXIST. LAMP WATTS	NEW LAMP WATTS	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR	NEW ANNUAL ENERGY KWH/YR	LIGHTING ENERGY SAVINGS KWH/YR	COOLING ENERGY SAVINGS KWH/YR	HEATING ENERGY PENALTY LBS/YR
3	6	4	2	34	32	2080	2,047	1,548	499	89	727
4	4	4	2	34	32	2080	1,364	1,032	332	59	484
5	4	4	2	34	32	2080	1,364	1,032	332	59	484
6	4	4	2	34	32	2080	1,364	1,032	332	59	484
6	1	2	1	34	32	2080	171	129	42	7	61
7	3	4	2	34	32	2080	1,023	774	249	44	363
7	1	2	1	34	32	2080	171	129	42	7	61
11	3	4	2	34	32	2080	1,023	774	249	44	363
12	6	4	2	34	32	2080	2,047	1,548	499	89	727
13	6	4	2	34	32	2080	2,047	1,548	499	89	727
14	2	4	2	34	32	2080	682	516	166	29	242
22	6	4	2	34	32	2080	2,047	1,548	499	89	727
23	4	4	2	34	32	2080	1,364	1,032	332	59	484
25	3	4	2	34	32	2080	1,023	774	249	44	363
26	4	4	2	34	32	2080	1,364	1,032	332	59	484
27	8	4	2	34	32	2080	2,729	2,063	666	118	971
31	12	2	1	34	32	2080	2,047	1,548	499	89	727
45	1	4	2	34	32	2080	341	258	83	15	121
46	1	4	2	34	32	2080	341	258	83	15	121
46	1	2	1	75	59	2080	360	229	131	23	191
47	2	3	1.5	34	32	2080	512	387	125	22	182
47	2	3	1.5	75	59	2080	1,080	686	394	70	574
48	3	2	1	75	59	2080	1,080	686	394	70	574
49	2	3	1.5	75	59	2080	1,080	686	394	70	574
49	2	3	1.5	34	32	2080	512	387	125	22	182
52	4	4	2	75	59	2080	2,879	1,830	1,049	186	1,529
54	2	2	1	75	59	2080	720	458	262	46	382

Figure E-1. Energy Savings Calculations (Continued)

ROOM NO.	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	BALLAST PER FIXTURE	LAMP WATTS	LAMP WATTS	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR	NEW ANNUAL ENERGY KWH/YR	LIGHTING ENERGY SAVINGS KWH/YR	COOLING ENERGY SAVINGS KWH/YR	HEATING ENERGY PENALTY LBS/YR
61	2	2	1	110	110	2080	1,069	458	611	108	891
95	96	4	2	34	32	2080	32,748	24,760	7,988	1,418	11,645
96	2	2	1	34	32	2080	341	258	83	15	121
100	18	2	1	110	110	2080	9,622	7,862	1,760	312	2,566
101	58	2	1	110	110	2080	31,004	25,334	5,670	1,006	8,266
102	28	2	1	75	59	2,082	10,085	6,413	3,672	652	5,353
103	16	3	1.5	110	110	2080	12,829	10,483	2,346	0	3,420
104	18	3	1.5	75	59	2080	9,716	6,178	3,538	628	5,158
105	105	2	1	75	59	2080	37,783	24,024	13,759	2,442	20,058
106	11	2	1	110	110	2080	5,880	4,805	1,075	0	1,567
107	56	2	1	110	110	2080	29,935	24,461	5,474	972	7,980
108	7	2	1	110	110	2080	3,742	3,058	684	121	997
109	18	2	1	110	110	2080	9,622	7,862	1,760	312	2,566
110	4	2	1	75	59	2080	1,439	915	524	93	764
111	72	2	1	110	110	2080	38,488	31,450	7,038	0	10,260
112	54	2	1	110	110	2080	28,866	23,587	5,279	0	7,696
113	16	2	1	110	110	2080	8,553	6,989	1,564	0	2,280
114	202	2	1	110	110	2080	107,981	88,234	19,747	3,505	28,787
115	115	2	1	110	110	2080	61,474	50,232	11,242	0	16,388
116	96	2	1	110	110	2080	51,318	41,933	9,385	0	13,681
117	75	2	1	110	110	2080	40,092	32,760	7,332	0	10,689
118	30	2	1	110	110	2080	16,037	13,104	2,933	0	4,276
119	153	2	1	110	110	2080	81,788	66,830	14,958	2,655	21,806
120	187	2	1	110	110	2080	99,963	81,682	18,281	3,244	26,650
121	115	2	1	110	110	2080	61,474	50,232	11,242	0	16,388
122	48	2	1	110	110	2080	25,659	20,966	4,693	0	6,841
123	80	2	1	110	110	2080	42,765	34,944	7,821	0	11,401

Figure E-1. Energy Savings Calculations (Continued)

ROOM NO.	EXIST. FIXTURE QTY.	LAMPS PER FIXTURE	BALLAST PER FIXTURE	LAMP WATTS	LAMP WATTS	EXIST. ANNUAL HOURS	EXIST. ANNUAL ENERGY KWH/YR	NEW ANNUAL ENERGY KWH/YR	LIGHTING ENERGY SAVINGS KWH/YR	COOLING ENERGY SAVINGS KWH/YR	HEATING ENERGY PENALTY LBS/YR
124	65	2	1	110	110	2080	34,746	28,392	6,354	1,128	9,263
125	65	2	1	110	110	2080	34,746	28,392	6,354	1,128	9,263
126	65	2	1	75	59	2080	23,390	14,872	8,518	1,512	12,417
127	68	2	1	110	110	2080	36,350	29,702	6,648	1,180	9,691
128	85	2	1	110	110	2080	45,438	37,128	8,310	1,475	12,114
129	140	2	1	110	110	2080	74,838	61,152	13,686	2,429	19,951
130	45	2	1	110	110	2080	24,055	19,656	4,399	781	6,413
131	25	2	1	110	110	2080	13,364	10,920	2,444	0	3,563
132	55	2	1	110	110	2080	29,401	24,024	5,377	0	7,839
133	18	2	1	110	110	2080	9,622	7,862	1,760	312	2,566
134A	155	2	1	110	110	2080	82,857	67,704	15,153	0	22,090
134B	55	2	1	110	110	2080	29,401	24,024	5,377	0	7,839
135	18	2	1	110	110	2080	9,622	7,862	1,760	312	2,566
136	204	2	1	110	110	2080	109,050	89,107	19,943	3,539	29,073
137	148	2	1	110	110	2080	79,115	64,646	14,469	0	21,093
138	240	2	1	110	110	2080	128,294	104,832	23,462	4,164	34,203
139	55	2	1	110	110	2080	29,401	24,024	5,377	0	7,839
141	5	2	1	110	110	2080	2,673	2,184	489	87	713
142	230	2	1	110	110	2080	122,949	100,464	22,485	3,991	32,778
143	145	2	1	110	110	2080	77,511	63,336	14,175	2,516	20,664
TOTAL LIGHTING ENERGY							1,889,878	1,524,021	365,857	43,609	533,342

$$\Delta E_H = \frac{(332)(3413)(0.28)}{(0.73)(898)} = 484 \frac{lbs}{yr}$$

Using the total lighting and cooling energy savings calculated from Figure E-1, the total Electrical Energy Savings (ΔQ_{TE}) are determined as follows:

$$\Delta Q_{TE} = \left[(\Delta E_L + \Delta E_C) \ x \ \frac{3{,}413 \ BTU}{KWH}\right] x \ \frac{1 \ MMBTU}{1{,}000{,}000 \ BTU}$$

$$\Delta Q_{TE} = [(365,857 + 43,609) \; x \; 3,413] \; x \; \frac{1}{1,000,000} = 1,397.5 \; \frac{MMBTU}{yr}$$

The total Heating Energy Penalty (ΔQ_H) from Figure E-1 is as follows:

$$\Delta Q_H = 533,342 \frac{lbs}{yr} \; x \; 898 \; \frac{BTU}{lb} \; x \; \frac{1 \; MMBTU}{1,000,000 \; BTU} = 478.9 \; \frac{MMBTU}{yr}$$

E. Cost Estimate

The total implementation costs for this ECO were calculated on page E-7.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page E-8. The results of the analysis are listed in the project summary on page E-1.

REFERENCES

1. Based on typical ballast manufacturer's specifications for (2) 34 watt T12 lamps, standard magnetic ballast.
2. Based on typical ballast manufacturer's specifications for (2) 32 watt T8 lamps, electronic ballast.
3. Reference Appendix page B-1 for cooling system efficiency calculation.
4. Reference Appendix page B-1 for cooling period calculation.
5. Reference Appendix page B-1 for heating system efficiency calculation.
6. Reference Appendix page B-1 for heating period calculation.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Corpus Christi Army Depot, Corpus Christi, Texas

PROJECT NO: 03-0185.02 **DATE:** 4/4/95

BY: PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-E-1, Install Electronic Ballasts and T8 lamps In Existing Fluorescent Fixtures

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Installation of new lamp sockets in existing fluorescent fixtures	3,851	pair	0.2	30.00	23,106	8.00	30,808	53,914
Installation of new F32T8 electronic ballasts	344	ea	0.5	30.00	5,160	16.70	5,745	10,905
Installation of new F96T8 electronic ballasts	3,507	ea	0.5	30.00	52,605	29.38	103,036	155,641
Installation of new F32T8 lamps	688	ea	0.1	30.00	2,064	2.65	1,823	3,887
Installation of new F96T8 lamps	7,014	ea	0.1	30.00	21,042	10.27	72,034	93,076
				SUBTOTAL	103,977		213,446	317,423
				O & P @ 20%	20,795		42,689	47,613
				SUBTOTAL	124,772		256,135	365,036
				DESIGN @ 6%				21,902
				SUBTOTAL				386,938
				SIOH @ 5.5%				20,077
				TOTAL				$407,015

NOTE: These labor estimates here are based on experience with electrical contractors. The material costs are taken from the Energy Efficient Lighting Handbook, 1-800-DLA-BULB.

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: CCAD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: CCAD REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-02 LIGHTING SURVEY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-6
ANALYSIS DATE: 04-04-95 ECONOMIC LIFE 20 YEARS PREPARED BY: CAP

1. INVESTMENT

A. CONSTRUCTION COST	$ 365036.			
B. SIOH	$ 20077.			
C. DESIGN COST	$ 21902.			
D. TOTAL COST (1A+1B+1C)	$ 407015.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$	0.	
F. PUBLIC UTILITY COMPANY REBATE		$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)				$ 407015.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 17.14	1398.	$ 23953.	15.61	$ 373909.
B. DIST	$ .00	0.	$ 0.	17.56	$ 0.
C. RESID	$ .00	0.	$ 0.	19.97	$ 0.
D. NAT G	$ .00	0.	$ 0.	20.96	$ 0.
E. COAL	$ .00	0.	$ 0.	17.58	$ 0.
F. LPG	$ .00	0.	$ 0.	16.12	$ 0.
L. OTHER	$ 13.16	-479.	$ -6302.	14.74	$ -92896.
M. DEMAND SAVINGS			$ 0.	14.74	$ 0.
N. TOTAL		919.	$ 17651.		$ 281012.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 17651.

5. SIMPLE PAYBACK PERIOD (1G/4) 23.06 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 281012.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .69
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 1.21 %

APPENDIX F

(EEAP) LIGHTING STUDY SURVEY - SCOPE OF WORK
AND REVIEW COMMENTS

APPENDIX F
SCOPE OF WORK AND REVIEW COMMENTS

TABLE OF CONTENTS

DETAILED SCOPE OF WORK
CONTRACT NO. DACAC63-94-D-0015
DELIVERY ORDER NO.

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendix "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.

INSTALLATION	PROJECT TITLE
Corpus Christi AD	(EEAP) Lighting Survey Study

2. The work and other related data and services required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	DELIVERY SCHEDULE
a. Interim Submittal(s) and Related data for Studies (See Annex A for Number of Copies)	75 calendar days after receipt of signed D.O.
b. Pre-Final Submittal(s) (12 copies)	85 calendar days after approval of Interim submittal
c. Final Submittal (original and All Data Developed under this submital)	100 calendar days after approval of the Pre-final

(See Annex "A" page A-1 for Government Furnished Items)

3. The items of work included in this Delivery Order shall be in accordance with criteria furnished at the Scoping Conference held on April 19, 1994 at Corpus Christi AD. The services to be provided shall include, but not be limited to, the following Scope of Work.

a. Items of Work: (See the enclosed General and Detailed Scope of Work).

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.2 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.3 Provide project documentation for recommended ECOs as detailed herein.

1.4 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This audit is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this audit.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation as relates to lighting, as well as its effects on HVAC systems, and which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The audit shall consider the use of all lighting sources applicable to each building, system, or ECO, including all effects lighting system changes may have on HVAC systems.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, or O&M funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.6.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.6.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.6.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Engineering and Housing will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall immediately be designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio greater than 1.25 and a simple payback period of less than ten years. For ECAM projects, the $300,000 limitation may not apply; in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.6.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391, life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented), and a Project Development Brochure (PDB). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.6.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. O & M Energy Projects: An O&M Energy project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, $300,000 construction cost, SIR $\geq$ 1.25, and simple payback period of less than ten years. In addition, if the project would replace a system or equipment that is considered 'failed or failing' due solely to obsolete technology or inefficiency, the equipment to be replaced must have been in use for at least three years; and the simple payback period must be three years or less.

b. Low Cost/No Cost Projects. These are projects which the Director of Engineering Services (DES) can perform using his resources. Documentation shall be as required by the DES.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. Light levels shall be measured under typical operating conditions for all areas or spaces being evaluated. All test and/or measurement equipment shall be properly calibrated prior to its use. The requirements for color rendition and current maintenance and relamping practices shall be noted for consideration in the evaluations.

7.2 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. Construction cost estimates shall be provided and shall break out the costs associated with rehab work (architectural, electrical, mechanical) where applicable. Existing and proposed light levels shall be compared with levels recommended by the Illumination Engineering Society (IES) or the Corps of Engineers Architectural and Engineering Instructions (AEI) for the applicable space and activity. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included.The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Engineering Services, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a.All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b.All ECOs which were analysed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Engineering Services to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects.

1) Backup information as specified in par 5.1

2) For any recommendations that would require a different layout of fixtures, a one-line drawing of the area showing circuiting and switching is required.

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

FY94 LIGHTING AUDIT, CORPUS CHRISTI ARMY DEPOT, TEXAS

1. All facilities to be investigated in this audit are located at Corpus Christi Army Depot on the Corpus Christi Naval Air Station near Corpus Christi, Texas.

2. The General Scope of Work outlines requirements for the audit and the report; and the detailed scope of work lists the specific areas to be audited. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

3. The work consists of identifying and evaluating energy conservation opportunities (ECOs) for lighting systems in specific areas or facilities. A list of suggested ECOs is provided in Annex D. The ECOs in Annex D are to be evaluated as applicable for the areas or facilities listed in Annex E.

4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later than 180 days after Notice to Proceed.

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Entry Interview	10
Completion of Field Work	25
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Report	100

5. The installation representative for this contract will be Mr. Adan Pena, Energy Manager, Directorate of Engineering Services for Corpus Christi Army Depot.

6. Government-Furnished Information: The following documents will be furnished to the AE:

a. As-built drawings (as available) of buildings/systems listed in Annex E.

b. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

c. ETL 1110-3-282, Energy Conservation

d. TM 5-800-2, Cost Estimates, Military Construction

e. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

f. Architectural and Engineering Instructions, Design Criteria; Chapter 12, Electrical Criteria, 9 December 1991

g. The latest MCP Index

7. Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander Corpus Christi Army Depot ATTN: SDSCC-ECD (Pena) Corpus Christi, TX, 78419-6000 512-939-2093	1	2	2	1*
Commander U S AMC Installation and Service Activity ATTN: AMXEN-C (Mr Nache) Rock Island, IL, 61299 - 7190	-	1	1	-
Commander U. S. Army Engineer District, Fort Worth ATTN: CESWF-ED-MP (Mr Champagne) PO Box 17300 Fort Worth, TX, 76102 - 0300	1	3	3	1*
Commander USAED, Southwest ATTN: CESWD-PP-MM (Mr West) 1114 Commerce Street Dallas, TX, 75242 - 0216	-	1	1	-
Commander USAED, Mobile ATTN: CESAM-EN-CM (Battaglia) PO Box 2288; Mobile, AL 36628	1	1	1	-
Commander US Army Corps of Engineers ATTN: CEMP-ET (Mr Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314 - 1000	-	1	-	-
Commander US Army Logistics Evaluation Agency ATTN: LOEA-PL (Mr Keath) New Cumberland Army Depot New Cumberland, PA, 17070 - 5007	-	1	-	-

* Field Notes submitted in final form at interim submittal.

8. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

     Electricity - KWH, Dollars, BTU
     Fuel Oil - GALS, Dollars, BTU
     Natural Gas - THERMS, Dollars, BTU
     Propane - GALS, Dollars, BTU
     Other - QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

   * Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX E

LIST OF AREAS/FACILITIES TO BE AUDITED

1. Building 8

   a. Large Hangar

   b. Small Hangar

   c. Production areas with high-output fluorescent lighting

   d. Administrative areas with pendant fluorescent lighting

2. High-Bay Areas in the Following Hangars

   a. Hangar #43

   b. Hangar #44

   c. Hangar #45

   d. Hangar #47

Interim Submittal Meeting At CCAD
Review Comments / Minutes
11/16/95

Present at meeting:

C.A. Pieper, PE	Huitt Zollars, Inc., Project Manager
Leonel Farias, PE	CCAD, Chief of Facilities Engineering
Adan Pena	CCAD, Energy Coordinator

1. Provide names of vendors for occupancy sensors

2. Provide recommendations of sensor types and their applications

3. Provide specification for daylighting systems, proposed in study.

4. Emphasize that CCAD is doing good job on lighting efficiency at current time.

5. Emphasize the findings that 'process' energy consumption is the largest target area for energy conservation at the facility.

6. Provide information of steam trap survey, recommended to help save process energy.

7. Document why some areas were excluded from the study.

8. Expand Table of Contents to include Appendices contents.

9. CCAD to study report for a few weeks, then write letter with recommendations on project grouping.

Responses to Interim Submittal Meeting Comments
Included in Pre-Final Submittal
1/27/95

ITEM	RESPONSE
1.	Information was included in Appendix G, Sample Products
2.	Information was included in Appendix G, Sample Products
3.	Information was included in Appendix G, Sample Products
4.	See page 5, Recommended Maintenance & Operations Practices.
5.	See page 10, Utility Data.
6.	Information from 'Armstrong' was Faxed to Adan Pena, December, 1994.
7.	See page 1, Buildings Studied.
8.	See Table of Contents, Page i, and all Appendices have had separate Table of Contents added.
9.	Letter included with responses, see pages F-15 and F-16.

Interim Submittal Review Letter From CCAD

SDSCC-EFA

10 Jan 1995

MEMORANDUM FOR Huitt-Zollars, Attn: C.A. Pieper, P.E.

SUBJECT: (EEAP) LIGHTING SURVEY STUDY

1. Thank you for effecting a through and complete analysis of our lighting needs. Concur with your recommendations for energy conservation opportunities at pages 7 and 8 of the subject study. Our original thought was to submit one or two Energy Conservation Investment Program(ECIP) projects; however, Corpus Christi Army Depot would be better served if we could submit several Federal Energy Management Program (FEMP) projects. Our information sources have advised us that ECIP funds are extremely limited.

2. Recommend that you develop several projects for submittal into the FEMP. FEMP has a few requirements you should be familiar with. First the project must be maintenance or repair, each project must not exceed $300K, it must have a savings to investment ratio (SIR) of 1.25 or greater and it must have a 10 year or less payback. Last month the depot received a funded project from FEMP that had a 4 year simple payback and an SIR of 3.83. Additionally, recommend that you roll together several of our smaller projects with fast paybacks and large SIRs for submittal as one project. Lump together the other projects with less attractive features and submit those as well. The above suggestions could give the depot the edge it needs to be extremely competitive.

3. For additional information, point of contact is Adan Pena, Energy Coordinator, telephone 512-939-2093.

for Hadri Baudisso

LEONEL FARIAS P.E.
Chief, Facilities Engineering Division

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ▸ 1
To C.A. PIEPER	From CCAD, A. PEÑA
Dept./Agency HUITT-ZOLLARS	Phone # 512-939-2093
(817)335-1025	Fax # 512-937-8758

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

Responses to Interim Submittal Review Letter From CCAD
1/27/95

ITEM	RESPONSE
1.	Concur with comment, will proceed as directed.
2.	See page 11, Plan to Implement Projects.
3.	Noted.

Interim Submittal Review Comments From USAED, Mobile

MOBILE DISTRICT PROJECT REVIEW COMMENTS	Date: 16 Dec 94	Page 1 of 2
To: Richard Champagne, Fort Worth District, CESWF-ED-MP	From: (Section) CESAM-EN-DM (Reviewer) A. Battaglia 205-690-2618	
Project: EEAP Lighting Study Location: Corpus Christi AD, TX	Year: FY-94	Line Item No.:
Type of Action: Interim Submittal Review		

ITEM NO.	DRAWING NO. OR PAR. NO.	COMMENTS	REVIEW ACTION
1.	General	In several places throughout the report (for example page 3, 2nd paragraph) the term, "inclimate weather" is used. Please correct to "inclement weather".	
2.	Pg B-1	The report states that the closest location to CCAD listed in TM5-785, Engineering Weather Data, is Kelly AFB in San Antonio. I found Corpus Christi NAS on page 3-367 of TM5-785. Please check. If using the CCNAS data would change the results of an analysis above or below SIR = 1.25, then the calculation should be revised.	
3.	General	The following comments refer to cost estimating in general: a. Please include a separate line item (where applicable) for recircuiting, rerouting or installing new wire and conduit, especally in the high-bay areas. b. In the LCCA Summary Sheet, Line 1A, the Construction Cost should be the total contract cost of the project, including the contractor's overhead and profit. Please include a line item for the contractor's overhead & profit. c. In the LCCA Summary Sheet, Line 1B, SIOH, is the government's internal cost for supervision, inspection, & overhead. We use a standard figure of 5.5% of Line 1A. Please revise as needed. d. In the LCCA Summary Sheet, Line 1C, Design Cost, we usually use a value of 6% of Line 1A. For some small jobs, 6% is too low, and the values you have used seem more appropriate. Please check and revise if needed. The following comment is from Ron Dorsey, Electrical Engineer, CESAM-EN-DB.	
4.	ECO D-5	The use of 400W HPS lights at a mounting height of only 11 feet above the working surface will produce hot spots in the lighting distribution. Lower wattage lamps with wide distribution outputs shuld be used.	

Pre-Final Review Comments From USAED, Mobile

MOBILE DISTRICT PROJECT REVIEW COMMENTS		Date: 01 Feb 95	Page 1 of 1
To: Richard Champagne Fort Worth District, CESWF-ED-MP	From: (Section) CESAM-EN-DM (Reviewer) A. Battaglia 334-690-2618		
Project: EEAP Lighting Study Location: Corpus Christi AD, TX	Year: FY-94	Line Item No.:	
Type of Action: Interim Submittal Review			

DRAWING NO. OR PAR. ID.	COMMENTS	REVIEW ACTION
General	The AE has obviously done a thorough job on this study; and it is well presented. The "Plan To Implement Projects", starting on page 11 is excellent.	
General	One item is missing from the report. A copy of the AE's responses to the comments for the interim submittal should be included. This could be in the form of minutes of the Interim Presentation & Review Meeting. The responses are usually included in the same appendix as the scope of work. Not all of our comments on the interim submittal were incorporated in this submittal; if the responses had been included it would be easy to see why they were not. Usually there is a good reason for not incorporating a comment, but it should be documented. Please provide as an addendum.	

Responses to Interim Comments From USAED, Mobile
1/27/95

ITEM	RESPONSE
1	Concur, changed as directed.
2	Concur, new weather data obtained and incorporated into calculations.
3a	Concur, see revised cost estimates.
3b	Concur, see revised LCCA Summary Sheets.
3c	Concur, see revised LCCA Summary Sheets.
3d	Concur, see revised cost estimates. In some cases, a minimum estimated design fee was used, based on experience.
4	The facility already has 400W HPS lighting in use in some areas of the production area. Since these fixtures are 'low bay' types, designed for mounting heights from 10' up to about 18', they provide good coverage. This is why a similar type was specified in this study.

Responses to Prefinal Comments From USAED, Mobile
1/2/95

ITEM	RESPONSE
1	Noted.
2	Concur, included in final submittal.

APPENDIX G

SAMPLE PRODUCTS

APPENDIX G
SAMPLE PRODUCTS

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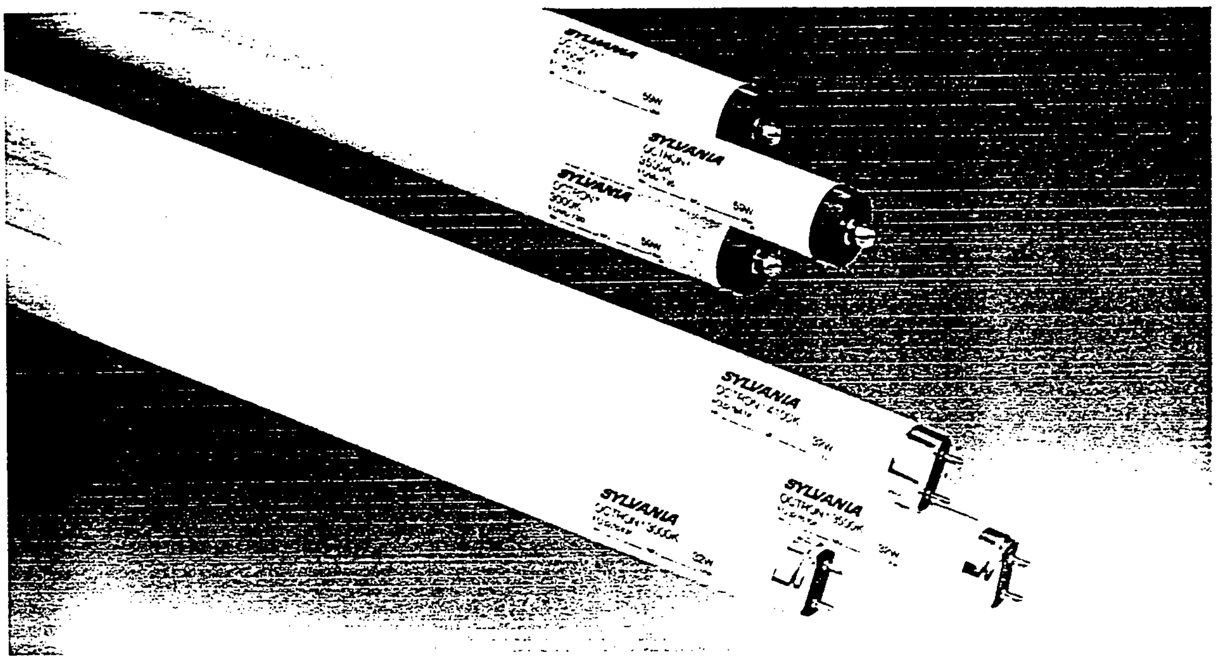
OCTRON®
Fluorescent Lamps



The Widest Range of T8 Lamps Available

Through its OCTRON® line OSRAM SYLVANIA offers more T8 lamp options than any other manufacturer. This gives architects, lighting designers, engineers, contractors and other specifiers the opportunity to select exactly the right mix of lamps to meet the precise requirements of an application.

All OCTRON lamps have a 20,000 hour average rated life when operated on rapid start ballasts. Lamps are rated at 15,000 hours when operated on instant start ballasts. (These figures are based on three hours of operation per start. Ratings will improve as burning cycles increase. In a typical 10 hour per day application, for example, life ratings on rapid start or instant start ballasts are increased by 35 percent.) Because long life means less frequent lamp replacement and smaller lamp inventories, maintenance costs can be substantially reduced.

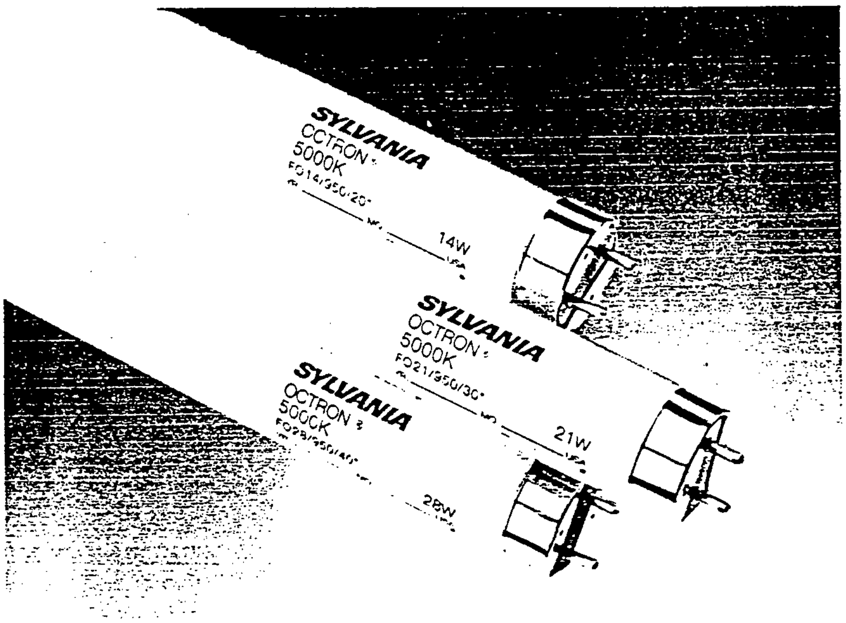
OCTRON® Bipin Linear Lamps

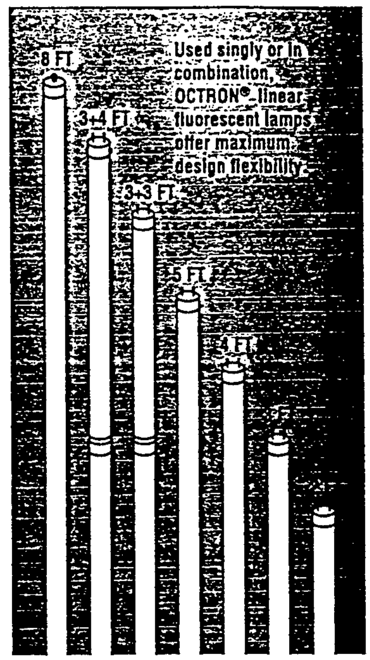
OCTRON bipin linear fluorescent lamps are available in four length/wattage combinations—2-foot (17W), 3-foot (25W), 4-foot (32W) and 5-foot (40W). This means there is an OCTRON T8 lamp to replace any commonly available bipin T12 lamp in any standard linear fluorescent fixture. OCTRON 700 Series lamps are available in four color temperatures— 3000K, 3500K, 4100K and 5000K—and have a color rendering index of 75. The 800 Series lamps come in 3000K, 3500K and 4100K colors and have an exceptional CRI of 85.

OCTRON® Single Pin Lamps

The OCTRON family includes an 8-foot single pin T8 lamp. When used in combination with an electronic ballast OCTRON FO96T8 lamps can replace F96T12 systems—saving over 90 watts per two-lamp fixture. The 15,000 hour average rated life of this innovative lamp is 25 percent longer than ordinary F96T12 lamps. In addition, the argon fill gas in OCTRON FO96T8 lamps is less temperature sensitive than the krypton gas commonly used in F96T12/SS lamps. This improves light output in applications where cold air circulates. Available in 700 Series (75 CRI) and 800 Series (85 CRI) versions with a choice of 3000K, 3500K and 4100K colors.

T8 Linear Fluorescent Lamps





OCTRON 900 Series lamps are the only T8 lamps available that are suitable for color critical applications.

OCTRON® 900 Series Lamps

The OCTRON® 900 Series offers the industry's only full color spectrum T8 fluorescent lamps. These high performance lamps are designed for a wide variety of color critical applications. Their CRI of 90 is the highest of any fluorescent lamp and they feature a color temperature of 5000K. The American National Standards Institute has specified 5000K light sources for color evaluation and comparisons. 5000K was chosen because it is the average color of daylight—an almost universal light source. OCTRON 900 Series lamps have a wide range of uses in graphic arts, textile and quality control applications where accurate color evaluation and comparisons are essential. They are also ideal for backlighting displays and translucent signs. OCTRON 900 Series lamps are available in the standard 2-foot, 3-foot, 4-foot and 5-foot lamp lengths as well as special 20-inch, 30-inch and 40-inch versions. Wattages range from 14 to 40 watts. For increased flexibility, different sizes of OCTRON 900 Series lamps may be operated on a single multi-lamp instant start electronic ballast with uniform lamp life

Understanding OCTRON® T8 Technology

OCTRON T8 lamps can be operated effectively on rapid start magnetic and rapid start electronic ballasts. However, specific elements of OCTRON T8 technology are designed to achieve maximum performance on high frequency, instant start electronic ballasts.

The primary benefit of running OCTRON T8 lamps on electronic ballasts is the ability to use less energy to produce a given amount of light. The energy savings come from the fact that an electronic ballast drives OCTRON T8 lamps at high frequency—20 000 Hz—compared to 60 Hz for a standard magnetic ballast. The increased frequency improves light output by up to 12 percent, allowing OCTRON lamps to provide dramatic energy cost savings while producing the same output as fluorescent T12 lamps. For even more savings, OCTRON fluorescent lamps may be operated with as little as 140 milliamps of current on instant start electronic ballasts.

OCTRON®
OCTRON® CURVALUME®
T8 Fluorescent Lamps

OCTRON® 700 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
17	T-8	24	Medium Bipin	21849	F017/730	20000	1325	3000K	75
17	T-8	24	Medium Bipin	21832	F017/735	20000	1325	3000K	75
17	T-8	24	Medium Bipin	21831	F017/741	20000	1325	4100K	75
25	T-8	36	Medium Bipin	21851	F025/730	20000	2125	3000K	75
25	T-8	36	Medium Bipin	21817	F025/735	20000	2125	3500K	75
25	T-8	36	Medium Bipin	21829	F025/741	20000	2125	4100K	75
32	T-8	48	Medium Bipin	21852	F032/730	20000	2850	3000K	75
32	T-8	48	Medium Bipin	21823	F032/735	20000	2850	3500K	75
32	T-8	48	Medium Bipin	21824	F032/741	20000	2850	4100K	75
32	T-8	48	Medium Bipin	21809	F032/750	20000	2650	5000K	75
40	T-8	60	Medium Bipin	21853	F040/730	20000	3500	3000K	75
40	T-8	60	Medium Bipin	21820	F040/735	20000	3600	3500K	75
40	T-8	60	Medium Bipin	21827	F040/741	20000	3600	4100K	75
59	T-8	96	Single Pin	21854	F096/730	15000	5700	3000K	75
59	T-8	96	Single Pin	21839	F096/735	15000	5700	3500K	75
59	T-8	96	Single Pin	21840	F096/741	15000	5700	4100K	75

OCTRON® 800 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
17	T-8	24	Medium Bipin	21903	F017/830	20000	1400	3000K	85
17	T-8	24	Medium Bipin	21904	F017/835	20000	1400	3500K	85
17	T-8	24	Medium Bipin	21905	F017/841	20000	1400	4100K	85
25	T-8	36	Medium Bipin	21913	F025/830	20000	2225	3000K	85
25	T-8	36	Medium Bipin	21914	F025/835	20000	2225	3500K	85
25	T-8	36	Medium Bipin	21915	F025/841	20000	2225	4100K	85
32	T-8	48	Medium Bipin	21923	F032/830	20000	3000	3000K	85
32	T-8	48	Medium Bipin	21924	F032/835	20000	3000	3500K	85
32	T-8	48	Medium Bipin	21925	F032/841	20000	3000	4100K	85
36	T-8	48	Medium Bipin	21930	F036/830	20000	3450	3000K	85
36	T-8	48	Medium Bipin	21931	F036/835	20000	3450	3500K	85
36	T-8	48	Medium Bipin	21932	F036/841	20000	3450	4100K	85
40	T-8	60	Medium Bipin	21938	F040/830	20000	3775	3000K	85
40	T-8	60	Medium Bipin	21939	F040/835	20000	3775	3500K	85
40	T-8	60	Medium Bipin	21940	F040/841	20000	3775	4100K	85
59	T-8	96	Single Pin	21897	F096/830	15000	6000	3000K	85
59	T-8	96	Single Pin	21898	F096/835	15000	6000	3500K	85
59	T-8	96	Single Pin	21899	F096/841	15000	6000	4100K	85

OCTRON® 900 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
14	T-8	20	Medium Bipin	21868	F014/950/20	20000	750	5000K	90
17	T-8	24	Medium Bipin	21871	F017/950/24	20000	800	5000K	90
21	T-8	30	Medium Bipin	21869	F021/950/30	20000	1000	5000K	90
25	T-8	36	Medium Bipin	21872	F025/950/36	20000	1250	5000K	90
28	T-8	40	Medium Bipin	21870	F028/950/40	20000	1400	5000K	90
32	T-8	48	Medium Bipin	21880	F032/950/48	20000	1675	5000K	90
40	T-8	60	Medium Bipin	21873	F040/950/60	20000	2200	5000K	90

Ordering Information

OCTRON® CURVALUME® 700 Series T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
16	T-8	10.5	Medium Bipin	21792	FB016/730	20000	1225	3000K	75
16	T-8	10.5	Medium Bipin	21800	FB016/735	20000	1225	3500K	75
16	T-8	10.5	Medium Bipin	21802	FB016/741	20000	1225	4100K	75
24	T-8	16.5	Medium Bipin	21794	FB024/730	20000	2025	3000K	75
24	T-8	16.5	Medium Bipin	21810	FB024/735	20000	2025	3500K	75
24	T-8	16.5	Medium Bipin	21804	FB024/741	20000	2025	4100K	75
31	T-8	22.5	Medium Bipin	21796	FB031/730	20000	2750	3000K	75
31	T-8	22.5	Medium Bipin	21807	FB031/735	20000	2750	3500K	75
31	T-8	22.5	Medium Bipin	21806	FB031/741	20000	2750	4100K	75
31	T-8	22.5	Medium Bipin	21819	FB031/750	20000	2550	5000K	75
32	T-8	22.5	Medium Bipin	21967	FB032/730/6	20000	2850	3000K	75
32	T-8	22.5	Medium Bipin	21968	FB032/735/6	20000	2850	3000K	75
32	T-8	22.5	Medium Bipin	21969	FB032/741/6	20000	2850	4100K	75

OCTRON® CURVALUME® 800 Series T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
16	T-8	10.5	Medium Bipin	21834	FB016/830	20000	1300	3000K	85
16	T-8	10.5	Medium Bipin	21835	FB016/835	20000	1300	3500K	85
16	T-8	10.5	Medium Bipin	21836	FB016/841	20000	1300	4100K	85
24	T-8	16.5	Medium Bipin	21874	FB024/830	20000	2125	3000K	85
24	T-8	16.5	Medium Bipin	21875	FB024/835	20000	2125	3500K	85
24	T-8	16.5	Medium Bipin	21876	FB024/841	20000	2125	4100K	85
31	T-8	22.5	Medium Bipin	21877	FB031/830	20000	2900	3000K	85
31	T-8	22.5	Medium Bipin	21878	FB031/835	20000	2900	3500K	85
31	T-8	22.5	Medium Bipin	21879	FB031/841	20000	2900	4100K	85
32	T-8	22.5	Medium Bipin	21970	FB032/830/6	20000	3000	3000K	85
32	T-8	22.5	Medium Bipin	21971	FB032/835/6	20000	3000	3500K	85
32	T-8	22.5	Medium Bipin	21972	FB032/841/6	20000	3000	4100K	85

Sample Specifications

OCTRON®

Lamps shall be SYLVANIA OCTRON® ______ (FO17, FO25, FO32, FO36*, FO40, FO96) having a T8 bulb and ______ (medium bipin, single pin**) bases. Lamps shall have a correlated color temperature of_____ (3000K, 3500K, 4100K, 5000K) and a color rendering index of _____ (75, 85). They are to be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

*Available only in 800 Series
**FO96 only

OCTRON® CURVALUME®

Lamps shall be SYLVANIA OCTRON® CURVALUME® ______ (FBO16, FBO24, FBO31, FBO32*) having a _____ (1⅝", 6") leg spacing and medium bipin bases. Lamps shall have a correlated color temperature of _____ (3000K, 3500K, 4100K, 5000K) and a color rendering index of _____ (75, 85). They are to be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

*FBO32 is the only CURVALUME lamp with 6" leg spacing

OCTRON® 900 Series

Lamps shall be SYLVANIA OCTRON 900 Series fluorescent lamps having medium bipin bases. Lamps shall have a correlated color temperature of 5000K and a color rendering index of 90. Lamp lengths shall be _____ (20", 24", 30", 36", 40", 48", 60"). Lamps shall be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

For Orders And General Information

OSRAM SYLVANIA National Customer Support Center, 18725 N. Union Street, Westfield, IN 46074

Industrial/Commercial Phone: 800/255-5042 Fax: 800/255-5043

Consumer Products Phone: 800/842-7010 Fax: 800/842-7011

Specialty Lamps Markets Phone: 800/762-7191 Fax: 800/762-7192

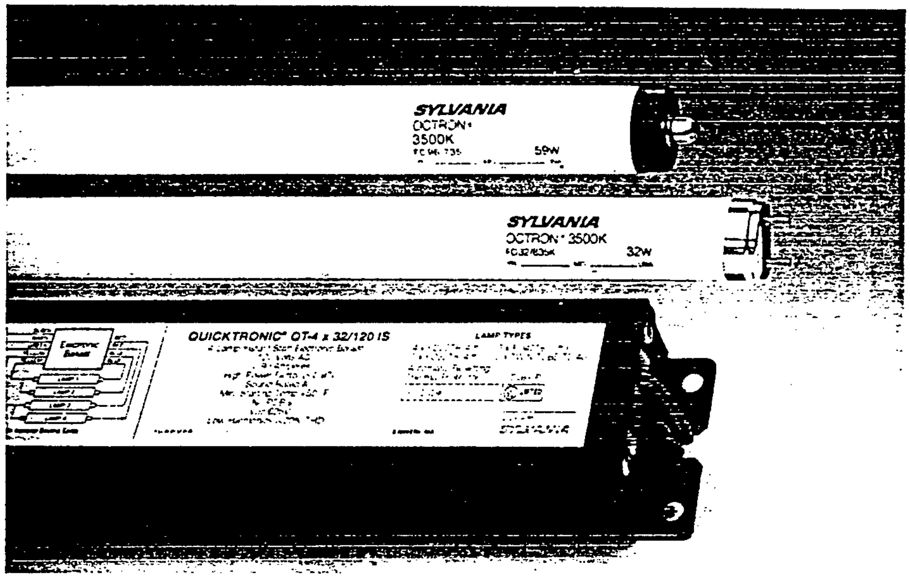
National Accounts:
Industrial Commercial Phone: 800/562-4671
Consumer Products Phone: 800/562-4672
Fax: 800/562-4674

Electronic Lighting Systems

The System Solution

A Complete Range of Fluorescent Systems

OSRAM SYLVANIA offers a QUICKTRONIC® system to provide optimum performance with every OCTRON® and OCTRON® CURVALUME® T8 lamp. There are also QUICKTRONIC systems for DULUX® L and F96T12 lamps. All QUICKTRONIC systems have a high ballast factor and high frequency circuitry for maximum light output and efficiency with minimal lamp flicker. Multi-lamp ballasts power up to four lamps with parallel circuitry that keeps remaining lamps lit when one or more fails. QUICKTRONIC systems are ideal for either retrofit or new installations.



QUICKTRONIC® SYSTEM 32

QUICKTRONIC SYSTEM 32 is designed to use OCTRON 32W T8 fluorescent lamps and provides illumination equal to an F40T12 system with 40 percent less energy usage. It can also operate 17W, 25W and 40W T8 lamps, OCTRON CURVALUME lamps and 40W T5 twin lamps. QUICKTRONIC SYSTEM 32 is available in 120V and 277V versions to drive one, two, three and four-lamp systems.

OCTRON and OCTRON CURVALUME T8 lamps are available in 75, 85 and 90 CRI versions and provide energy savings, high luminous efficacy and excellent color rendition. The DULUX L 40W is a single ended twin tube lamp that provides nearly the same light output as a 4-foot linear lamp.

QUICKTRONIC® SYSTEM 36

QUICKTRONIC SYSTEM 36 is designed to operate OCTRON 36W T8 lamps. It provides up to 30 percent more lumen output than a standard 32W T8 system. It also operates DULUX L 39W twin tube fluorescent lamps. QUICKTRONIC SYSTEM 36 is a two-lamp system available in 120V and 277V versions.

OCTRON 36W T8 lamps are available in 3000K, 3500K and 4100K versions and have a CRI of 85. They provide exceptional luminous efficacy and energy efficiency. The DULUX L 39W single ended twin tube lamp provides nearly the same light output as a 4-foot linear lamp and has an efficacy of up to 81 lumens per watt.

QUICKTRONIC® SYSTEM 59

QUICKTRONIC SYSTEM 59 is designed to operate OCTRON FO96T8 lamps. It provides illumination equal to F96T12 lamps with 40 percent less energy usage. Because it is smaller and lighter than the F96T12 magnetic ballast it replaces, installation is easier and more flexible. QUICKTRONIC SYSTEM 59 is a two-lamp system available in 120V and 277V versions.

OCTRON FO96T8 lamps have a single pin base and are designed to replace F96T12 lamps. OCTRON FO96T8 lamps come in three color temperatures—3100K, 3500K and 4100K and are available in 75 CRI and 85 CRI versions.

QUICKTRONIC® SYSTEMS

QUICKTRONIC® SYSTEM 17

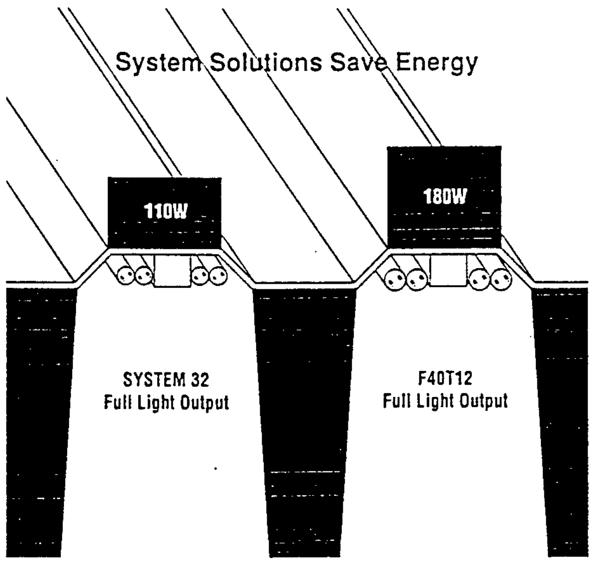
QUICKTRONIC® SYSTEM 17 is designed to operate OCTRON® 17W T8 and OCTRON® CURVALUME® 16W lamps with full energy efficiency, high lumen output and low harmonic distortion. QUICKTRONIC SYSTEM 17 is a three-lamp system available in 120V and 277V versions.

OCTRON 17W T8 and OCTRON CURVALUME 16W lamps are available in both 75 and 85 CRI versions. When used in QUICKTRONIC SYSTEM 17 they provide energy savings, high luminous efficacy and excellent color rendering.

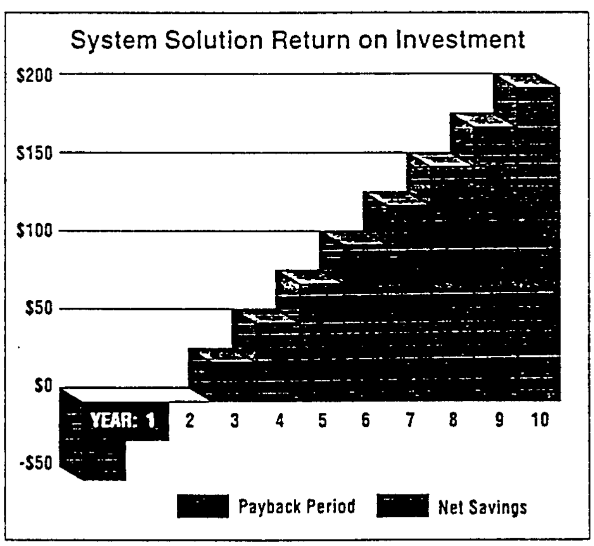
QUICKTRONIC® SYSTEM 96

QUICKTRONIC SYSTEM 96 is designed to operate both standard and energy saving SYLVANIA F96T12 lamps and F96T12/HO lamps. It provides high lumen output, extremely efficient operation and up to 20 percent energy savings when compared to older magnetic ballasts. Other T12, SLIMLINE and H.O. lamps can also be driven. QUICKTRONIC SYSTEM 96 is a two-lamp system available in 120V and 277V versions.

SYLVANIA F96T12 SLIMLINE and F96T12 High Output lamps are available in a range of colors with up to 80 CRI. Standard and energy saving versions are available.



Power Input vs. Light Output for QUICKTRONIC® System 32 Compared to F40T12 System



10 Year Payback on QUICKTRONIC® System 32 vs. F40T12 System

QUICKTRONIC® SYSTEM 55

QUICKTRONIC SYSTEM 55 is designed to operate DULUX® L 55W twin tube fluorescent lamps. It provides up to 50 percent more lumen output than standard T5 twin lamps with no loss in system efficiency. This is the ideal system for high lumen indirect, cove and 2x2 fixtures. QUICKTRONIC SYSTEM 55 is offered as a one or two-lamp system in 120V and 277V versions.

DULUX L 55W twin tube lamps provide up to 50 percent more light output than standard T5 twin lamps. DULUX L lamps offer an efficacy of up to 81 lumens per watt and are available in 3000K, 3500K and 4100K versions.

OSRAM SYLVANIA
System Solutions

Ordering Information

QUICKTRONIC® Electronic Systems for Fluorescent Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49256	QT1X32/120IS	120	32W-T8	1	31	.93	<20
49257	QT1X32/277IS	277	32W-T8	1	31	.93	<20
49270	QT2X32/120IS	120	32W-T8	2	62	.95	<20
49268	QT2X32/277IS	277	32W-T8	2	62	.95	<20
49258	QT3X32/120IS	120	32W-T8	3	88	.93	<20
49260	QT3X32/277IS	277	32W-T8	3	88	.93	<20
49265	QT4X32/120IS	120	32W-T8	4	110	.87	<20
49263	QT4X32/277IS	277	32W-T8	4	110	.87	<20
49262	QT2X36/120IS	120	36W-T8	2	78	1.05	<20
49257	QT2X36/277IS	277	36W-T8	2	78	1.05	<20
49340	QT2X59/120IS	120	59W-T8	2	105	.85	<20
49346	QT2X59/277IS	277	59W-T8	2	105	.85	<20
49252	QT3X17/120IS	120	17W-T8	3	50	.95	<20
49253	QT3X17/277IS	277	17W-T8	3	50	.95	<20
49250	QT2X96/120IS	120	F96T12	2	135	.88	<20
49254	QT2X96/277IS	277	F96T12	2	135	.88	<20
49255	QT2X96/120HO	120	F96T12/HO	2	210	.87	<20
49251	QT2X96/277HO	277	F96T12/HO	2	210	.87	<20
49287	QT2X55/120IS	120	55W Dulux L	2	110	1.00	<20
49288	QT2X55/277IS	277	55W Dulux L	2	110	.91	<20

ACCUTRONIC™ Low Voltage DC Electronic Systems for Compact Fluorescent Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49401	AT7-9/12	12	7-9W Dulux SE & DE	1	10	1.00	
49400	AT7-9/24	24	7-9W Dulux SE & DE	1	10	1.00	

POWERTRONIC™ Electronic Systems for HID Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49300	PT-DE 70/120	120	70W HQI-DE	1	80	1.00	<10
49301	PT-DE 70/277	277	70W HQI-DE	1	80	1.00	<10

For Orders And General Information

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Specialty Lamps/Markets Phone: 800/762-7191 Fax: 800/762-7192

National Accounts:

Industrial/Commercial Phone: 800/562-4671

Consumer Products Phone: 800/562-4672 Fax: 800/562-4674

SECTION 16580 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section includes furnishing, installing, and programming of the automatic photo control system for interior lighting.

B. The intent of this specification is to provide complete and functioning lighting control systems and requires that all equipment, fittings, and peripheral devices for correct system operation be quoted and supplied. Differences in opinion regarding the interpretation of these specifications shall be decided by the Engineer, whose decision shall be final. All general conditions and provisions of the main contract shall apply to this section.

C. Each system shall operates as follows: The hangar lighting circuits shall be divided into two areas, each with three "lighting level" control groups. This shall provide full and low levels of building lighting. The system shall rotate the fixtures that are on in the low level to equalize lamp life in all fixtures.

1.02 REFERENCES

A. Installation must comply with the applicable standards and codes. Equipment shall be UL listed and labeled.

1.03 SUBMITTALS

A. Prior to fabrication, submittal drawings shall have been provided to and approved by the engineer.

1.04 QUALITY ASSURANCE

A. Manufacturer shall have been regularly engaged in the manufacturer of lighting automation equipment for a period of at least ten years.

B. Manufacturer shall provide a complete checkout of system installation prior to the energizing of equipment. On this same trip, manufacturer shall provide the designated owner's representative with a minimum of five hours training in the operation and maintenance of the system. Contractor shall provide manufacturer and owner at least fourteen days notice to schedule check-out and demo.

1.05 WARRANTY

A. Submit manufacturer's warranty that equipment shall be guaranteed for one year from date of acceptance by owner.

PART 2 - PRODUCTS

2.01 LIGHTING CONTROL SYSTEMS, GENERAL

A. Provide one time/daylighting automation system for the automatic switching of lighting as described herein and at each location indicated on drawings.

B. Each system shall consist of a master relay automation panel, remote photocell sensors and a remote master station.

1. The contactor panel shall consist of multiple electrically operated/electrically held contactors rated at 20 amps 277 volts. Provide 36 relays with wired space for a total of 48 relays. All contactors are controlled from the automation panel.

2. The automation control shall provide two channels of time control plus two channels of photocell control. Any contactor may be assigned to the time program and/or either of the two photocell programs. The time clock shall be a seven day, programmable electronic time clock with battery backup. The photo control shall provide two discreet channels of control. Each channel of control shall be adjustable for daylight enhancement levels of 200-2500 fc. This shall allow full range interior control. Each control shall provide two different switch points, based on two specific light levels. A minimum of 2% hysteresis shall be provided to switch lights on and off at different levels. The setpoints shall be separated by an adjustable "deadband" to eliminate false switching. System shall also provide rotation of "base level" lighting circuits.

3. For each system, two remote photo sensors shall be mounted in accordance with manufacturer's recommendations. The range shall be 200-2500 fc. Provide one spare photo sensor. Sensor shall be matched to human eye response range.

4. The master panel shall be wall mounted with permanent labeling and six master ON/OFF override switches.

C. Equipment specified is by Edwin Jones Company, Inc., Dallas, TX (800-369-4010). All cabinets shall be factory prewired and bear the UL label. If the contractor desires to use alternate equipment, the desired substitution must be submitted at least 10 days before bid date. Submittal shall include: a complete bill of material, data sheets on proposed equipment, an itemized specification compliance index, and a list of installations of the proposed equipment. Approved equipment will be listed in an addendum.

PART 3 - EXECUTION

3.01 INSTALLATION

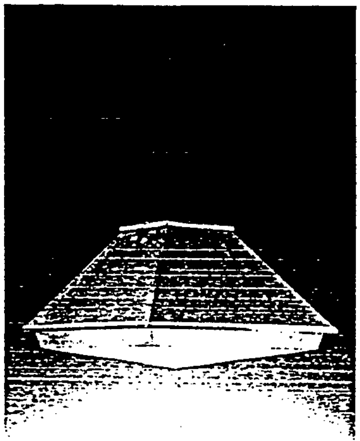
A. The system shall be installed in a craftsman-like manner and in compliance with all applicable local and national codes. All wiring in cabinets and control cabinets shall be in a neat manner with all conductors labeled and neatly harnessed with wire ties. All equipment shall be protected from dirt, paint, and construction debris.

B. Prior to receiving power from the cabinet, each branch circuit shall be tested for shorts and any shorts corrected. Prior to inspection by the engineer and technician, all equipment shall be cleaned with all dust, metal cuttings, wire clippings, spilled or over-sprayed paint, and miscellaneous debris removed.

3.02 ENERGIZATION

A. The manufacturer shall provide a factory trained technician to inspect the system for proper installation, test it for proper operation, and program the system as directed by the Engineer. Any wiring or installation errors noted by the factory technician shall be corrected by the contractor at no charge to the owner.

END OF SECTION



BenchMark SM

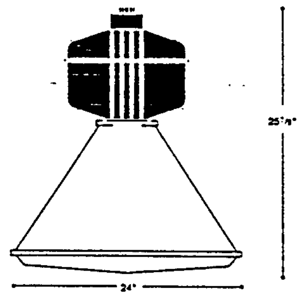
150-400 WATT HPS/MH/MV

Heavy Duty Industrial—Square Low-Bay

Applications

The BenchMark SM's Triumph I, KAMAX[1] lens delivers high efficiency, square beam distribution... and its heavy-duty housing is a rugged performer in harsh or damp applications. Perfect for assembly or manufacturing areas, warehouses and storage facilities.

Dimensions



Ordering Information

Catalog Number Logic

Lamp Type	Product Family	Lens Type	Fixture Size Inches	Lens Material	Lamp Wattage/Base	Voltage
HP=HPS MH=Met. Hal. MV=Merc.	SM=Square Low-Bay	TR=Triumph I Injection Molded KAMAX[1] Acrylic	24=24"	K=KAMAX[1] Acrylic P=Polycarbonate	150=150W/Mogul 175=175W/Mogul 250=250W/Mogul 400=400W/Mogul	120=120 Volt 208=208 Volt 240=240 Volt 277=277 Volt 480=480 Volt MT=Multi-Tap

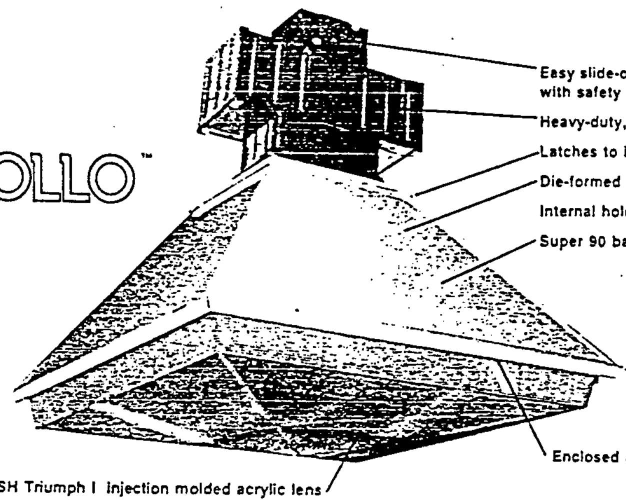
Catalog[1] Number	Lamp[2] Type	Lamp Wattage	Net. Wt. (Lbs.)	Shipping Volume
HPSM-TR24K-150[3]	HPS	150	28	Ballast-
HPSM-TR24K-250	HPS	250	31	1/ctn.
HPSM-TR24K-400	HPS	400	39.5	1.45 cu. ft.
MHSM-TR24K-175	MH	175	28.5	
MHSM-TR24K-250	MH	250	33	
MHSM-TR24K-400	MH	400	36.5	Reflector-
MVSM-TR24K-175	Merc.	175	30	1/ctn.
MVSM-TR24K-250	Merc.	250	31	5.90
MVSM-TR24K-400	Merc.	400	33	

[1] Add desired voltage to end of catalog number—120, 208, 240, 277 or 480 Volt. Multi-Tap ballasts are 120/208/240/277 Volt.
[2] Standard lamp is mogul base. Not included
[3] Uses S-55 (55 Volt lamp only)

KAMAX[1] is a registered trademark of Rohm and Haas Company

Lumark® Industrial Low Bay Features

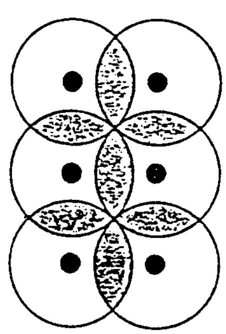
APOLLO™



APOLLO offers square light distribution.

More accurate lighting design. Excellent lighting uniformity. Lower watts per square foot.

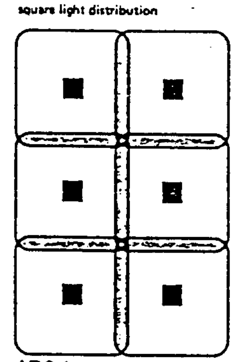
Conventional low mounting fixture
circular light distribution



4374 sq. ft.
AREA COVERED

Fixture: Brand X
Watts per sq. ft.: .64
Initial Footcandles: 51
Fixture Spacing: 27'x27'
Lamp: 400 watt H.P.S.
Mt. Height: 16 ft.

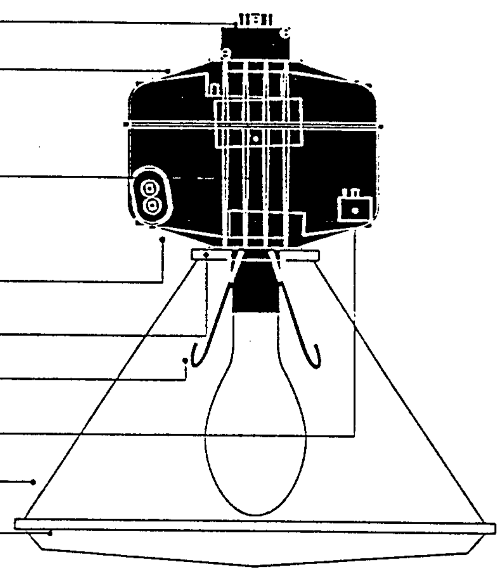
APOLLO
square light distribution



4704 sq. ft.
AREA COVERED

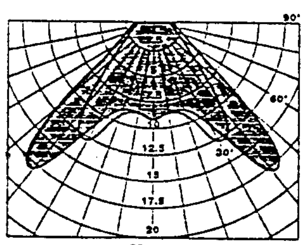
Fixture: Apollo
Cat. No.: [illegible]
Watts per sq. ft.: .59
Initial Footcandles: 51
Fixture Spacing: 28'x28'
Lamp: 400 watt H.P.S.
Mt. Height: 16 ft.

Design Features



Photometrics

SM-1
Catalog Number HPSM-TR24A-400
400-Watt HPS
50,000-Lumen Clear Lamp



Candle Power

DEG. ACROSS	45°		DEG. ACROSS	45°	
0	8481	8481	55	4603	6391
5	8468	8517	65	3123	3590
15	8750	8548	75	2069	2360
25	11210	9366	85	1266	1494
35	13674	16040	90	888	1059
45	6352	16768			

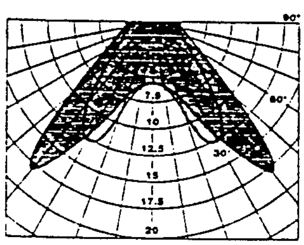
Spacing Criterion 1.8

ZONE	%Lamp
0-30	16 18
0-40	32 90
0-60	59 55
0-90	74 05
90-180	3 93
TOTAL	77.98

Effective floor cavity reflectance 0.20

RC	80			70			50		30	
RW	70	50	30	70	50	30	50	30	50	30
RCR										
1	84	80	77	82	78	75	74	72	70	68
2	77	71	66	75	69	64	65	62	62	59
3	70	63	57	68	61	56	58	54	56	52
4	65	56	49	63	54	48	52	47	50	45
5	59	49	42	57	48	42	46	40	44	39
6	54	44	37	52	43	37	41	36	40	34
7	50	39	32	48	36	32	37	31	35	30
8	45	35	28	44	34	26	33	27	31	26
9	42	31	24	40	30	24	29	23	28	23
10	38	28	21	37	27	21	25	21	25	20

SM-2
Catalog Number MHSM-TR24A-400
400-Watt Metal Halide
34,000-Lumen Clear Lamp



Candle Power

DEG. ACROSS	45°		DEG. ACROSS	45°	
0	5699	5699	55	2845	3604
5	5706	5639	65	1999	2240
15	5997	5797	75	1330	1484
25	8950	6822	85	832	955
35	9197	15848	90	549	661
45	4744	9968			

Spacing Criterion 1.7

ZONE	%Lamp
0-30	17 76
0-40	37 51
0-60	62 13
0-90	75 72
90-180	3 12
TOTAL	78 84

Effective floor cavity reflectance 0.20

RC	80			70			50		30	
RW	70	50	30	70	50	30	50	30	50	30
RCR										
1	85	82	79	83	80	77	76	73	72	70
2	79	73	68	76	71	66	58	54	65	62
3	72	64	59	70	63	58	60	56	58	54
4	67	58	51	65	57	51	54	49	52	48
5	61	52	45	59	51	44	49	43	47	43
6	56	47	40	55	45	39	44	36	42	37
7	52	41	35	50	40	34	39	33	38	32
8	48	37	30	46	36	30	35	29	34	29
9	44	33	27	42	32	26	31	26	30	25
10	40	30	23	39	29	23	29	22	27	22

the Watt Stopper

Applications

The Watt Stopper manufactures the most complete line of automatic lighting controls. A combination of Ultrasonic, Passive Infrared and Dual Technology sensors can be used to configure any application. For specific information on how the technologies work see "Passive Infrared Sensor Technology", "Ultrasonic Technology", and "Dual Technology" sections under 'technical data'. Some of the most common uses are described here.

Office Buildings

The Watt Stopper occupancy sensors are the perfect product to control lighting in the office environment. With all three technologies, effective energy savings can be achieved in every space. Our recommendations are:

• OFFICES - WPIR, WI or WS series wall switches	15-70%	Savings
• OPEN OFFICE SPACES - CI-100, CI-200, W,1000A W2000A, DT-100L	5-25%	Savings
• CONFERENCE ROOMS - W500A, W1000A, DT-100L, CI-100	20-65%	Savings
• COMPUTER ROOMS - DT-100L, WPIR, CI-100	20-65%	Savings
• RESTROOMS - Ultrasonic sensors	30-75%	Savings
• CORRIDORS - CI-100-2, W2000H	30-60%	Savings

Colleges & Schools

The Watt Stopper occupancy sensors have been very successful in elementary, secondary, and college applications. For schools we recommend:

• LARGE CLASSROOMS - DT-100L, W2000A, CI-100, CI-200	20-75%	Savings
• SMALL CLASSROOMS - W1000A, CI-100, WPIR	0-75%	Savings
• CORRIDORS - CI-100-2, W2000H	30-60%	Savings
• RESTROOMS - Ultrasonic sensors	35-75%	Savings
• TEACHERS OFFICES - WPIR, WI or WS series wall switches	30-50%	Savings
• GYM'S AND MULTIPURPOSE - DT-100L, CI-100	35-70%	Savings

Retail & Hotels

The Watt Stopper occupancy sensors help you reduce energy costs while still meeting the special needs of your customers. For the most dramatic savings we recommend:

• STORAGE AREAS - DT-100L, Ultrasonic, WPIR, CI-100, CI-200	45-65%	Savings
• MEETING ROOMS - DT-100L, W500A, W1000A, CI-100, CI-200	40-65%	Savings
• WAREHOUSES - DT-100L, W2000A, CI-100, CI-200	50-75%	Savings

HVAC, EMS, Light Level & Misc

HVAC and Energy Management Systems can be used in combination with any and all Watt Stopper products. Every sensor can be used to turn lighting on and off in addition to producing information or signals for the other systems.

- HVAC - Use the DT-100L, CI-100 or CI-200 for independent "on" and/or independent "off" for any area.
- EMS - The Watt Stopper sensors can be used to control lighting loads independently or in conjunction with EMS systems.
- Light Level - The DT-100L, CI-100 and CI-200 have a separate output to isolate a circuit for light level control.
- Cold Storage, Outdoor applications: CB-100, CB-200

The Watt Stopper®, Inc.
2800 De La Cruz Blvd
Santa Clara, CA 95050
Tel: (408) 988-5331
Fax: (408) 988-5373
National Technical Support
Plano, Texas: (800) 879-8585

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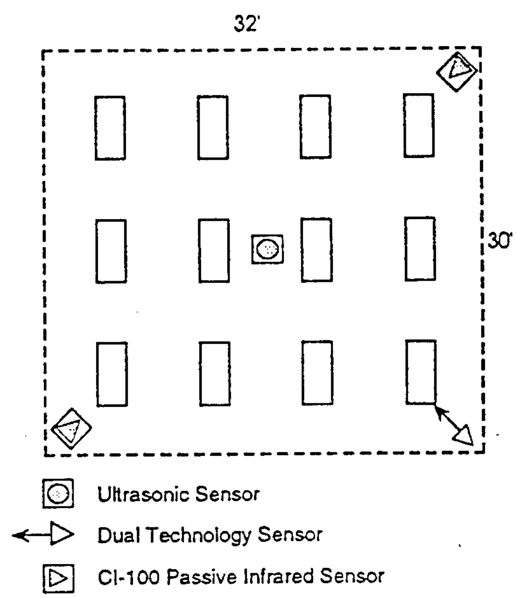
APPLICATION – OPEN OFFICE AREA

Ultrasonic, PIR, and Dual Technology Sensors in Open Office Area & Partitioned Offices



Application

1. Check square footage of area.
2. Use coverage templates.
3. Designing for smaller zones results in greater energy savings.
4. Make sure PIR sensors have clear view of the controlled area.
5. Specify time-delay to match activity level of the space.

Savings

(See enclosed "Timer Test Study")
For an open office area with
12 - 3 lamp fixtures = 1.44 Kw
x \$.10 per Kwh = \$.144 cost per hour

Save 4 hours per day Mon-Fri
Save 6.5 hours per weekend

Total hours saved = 26.5 hours x 52 weeks
= 1,378 hours per year

1,378 hour x \$.144 cost per hour
= \$198.43 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = \$125.00
Installation = \$60.00
Total Cost =\$185.00
Payback = 11.2 Months
ROI = 107%

DT-100L & power pack = \$160.00
Installation = \$60.00
Total Cost =\$220.00
Payback = 13.3 Months
ROI = 90%

2 - CI-100 sensors & power pack = \$180.00
Installation = \$90.00
Total Cost = \$270.00
Payback = 16.3 Months
ROI = 74%

**Sensor, power pack, and installation costs are approximate.

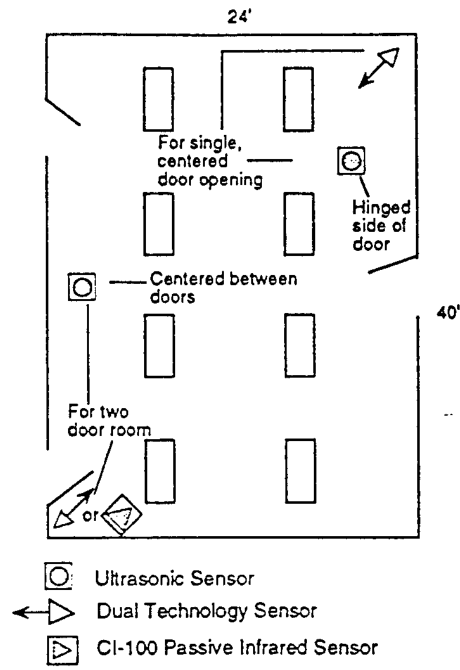
039JC2

Ultrasonic, PIR, and Dual Technology Sensors in Common Building Areas Larger Than 300 sq ft

Application

Conference rooms, computer rooms, maintenance areas, classrooms, vending areas, lunch rooms, copy rooms

1. Check square footage of area.
2. Use coverage templates.
3. Make sure PIR sensors have clear view of the controlled area.
4. Place sensor or "mask" lens so it does not "see" outside the room.
5. Specify time-delay and sensitivity to match activity level of the space.



Savings

8 - 176 Watt 2' x 4' Troffers
= 1.41Kw x $.10 per Kwh
= $.141 cost per hour

Save 4 hours per day Mon-Fri
Save 12 hours per weekend

Total hours saved = 32 hours x 52 weeks
= 1,664 hours per year

1,664 hour x $.141 cost per hour
= $234.62 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = $125.00
Installation = $60.00
Total Cost =$185.00
Payback = 9.5 Months
ROI = 127%

DT-100L & power pack = $160.00
Installation = $60.00
Total Cost =$220.00
Payback = 11.3 Months
ROI = 107%

CI-100 & power pack = $100.00
Installation = $60.00
Total Cost =$160.00
Payback = 8.2 Months
ROI = 147%

039JC2

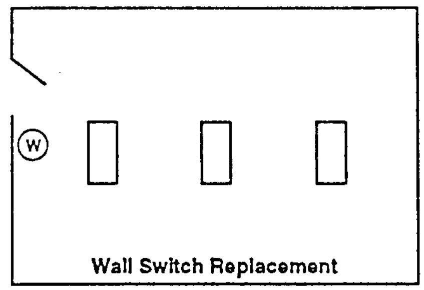
**Sensor, power pack, and installation costs are approximate.

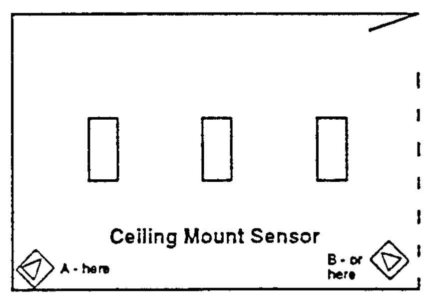
PIR Sensors and PIR Automatic Wall Switches in Building Areas of Under 300 Square Feet

Application

Offices, computer rooms, maintenance areas, vending areas, copy rooms, utility rooms.

1. Check square footage of area.
2. Use coverage templates.
3. Make sure PIR sensors have clear view of the controlled area.
4. Place sensor or "mask" lens so it does not "see" outside the room.
5. Specify time-delay and sensitivity to match activity level of the space.





(W) WI or WS Series
Automatic Wall Switch

WPIR Sensor
For enclosed office, use placement A or B. If the wall on the right does not exist, use placement B.

Savings

3 - 176 Watt 2' x 4' Troffers
= .528Kw x \$.10 per Kwh
= \$.053 cost per hour

Save 4 hours per day Mon-Fri
Save 12 hours per weekend

Total hours saved = 32 hours x 52 weeks
= 1,664 hours per year

1,664 hour x \$.053 per hour
= \$88.19 ANNUAL SAVINGS

Payback/ROI

WI or WS Wall Switch = \$60.00
Installation = \$20.00
Total Cost =\$80.00
Payback = 10.9 Months
ROI = 110%

WPIR & power pack = \$80.00
Installation = \$60.00
Total Cost =\$140.00
Payback = 19 Months
ROI = 63%

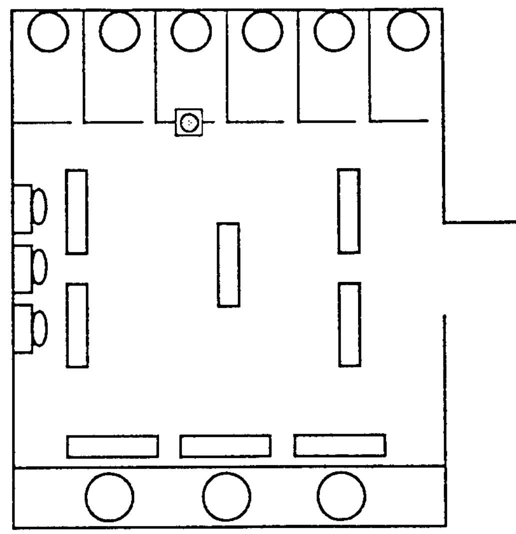
**Sensor, power pack, and installation costs are approximate.

Ultrasonic Sensors in Restrooms

Application

Large restrooms (with or without partitions).

1. Check square footage of area.
2. Use coverage templates.
2. Place sensor as close as possible to stalls. Ideally, over the top of stall entrance.
3. Make sure ultrasonic sensors are installed 6 to 8 feet away from air supply diffusers.
5. Specify time-delay and sensitivity to match activity level of the space.



Savings

(See enclosed "Timer Test Study")
8 - 80 Watt 2' x 4' Fluorescent fixtures
= .64Kw x .10 per Kwh
= $.064 cost per hour
(Consider exhaust fan and ballast load)

Save 8 hours per day Mon-Fri
(Typically lights in bathrooms are on 16 to 24 hours a day.)
Save 27 hours per weekend

Total hours saved = 67 hours x 52 weeks
= 3,484 hours per year

3,484 hour x $.064 per hour
= $222.98 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = $125.00
Installation = $60.00
Total Cost =$185.00
Payback = 9.9 Months
ROI = 121%

039JC2

**Sensor, power pack, and installation costs are approximate.

APPLICATION – HALLWAYS

Ultrasonic and PIR Sensors in Hallways

Application

Hallways, corridors, aisleways.

1. Check square footage and ceiling height of area.
2. Use coverage templates.
3. Do not use ultrasonic sensor if ceiling height exceeds 14 feet.
4. CI-100's are recommended for aisleways – do not use ultrasonics.
5. Make sure ultrasonic sensors are installed 6 to 8 feet away from air supply diffusers.
6. Point ultrasonic receiver openings down the hallway. Mount CI-100 with lens facing down the hallway.
7. Specify time-delay and sensitivity to match activity level of the space.

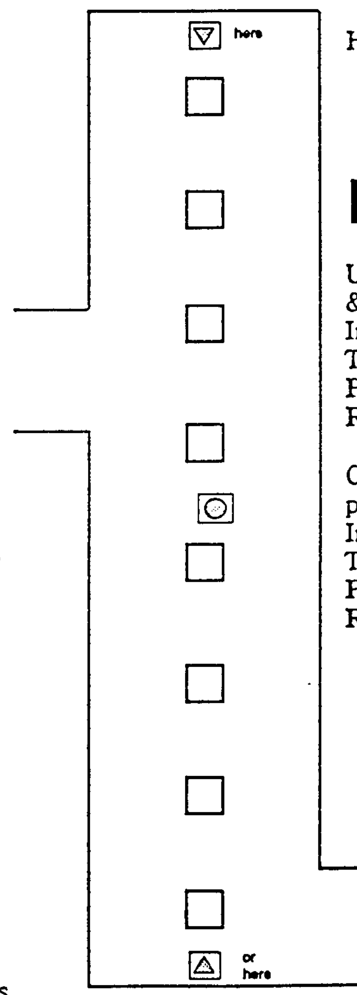
Savings

(See enclosed "Timer Test Study")
8 - 80 Watt 2' x 2' Troffers
= .64Kw x $ .10 per Kwh
= $.064 cost per hour

Save 12 hours per day Mon-Fri
Save 33 hours per weekend

Total hours saved = 93 hours x 52 weeks
= 4836 hours per year

4,836 hour x $.064 per hour
= $309.50 ANNUAL SAVINGS



Ultrasonic Sensor

CI-100 Passive Infrared Sensor

Hallway length = 80'

Payback/ROI

Ultrasonic sensor
& power pack = $125.00
Installation = $60.00
Total Cost =$185.00
Payback = 7.2 Months
ROI = 166%

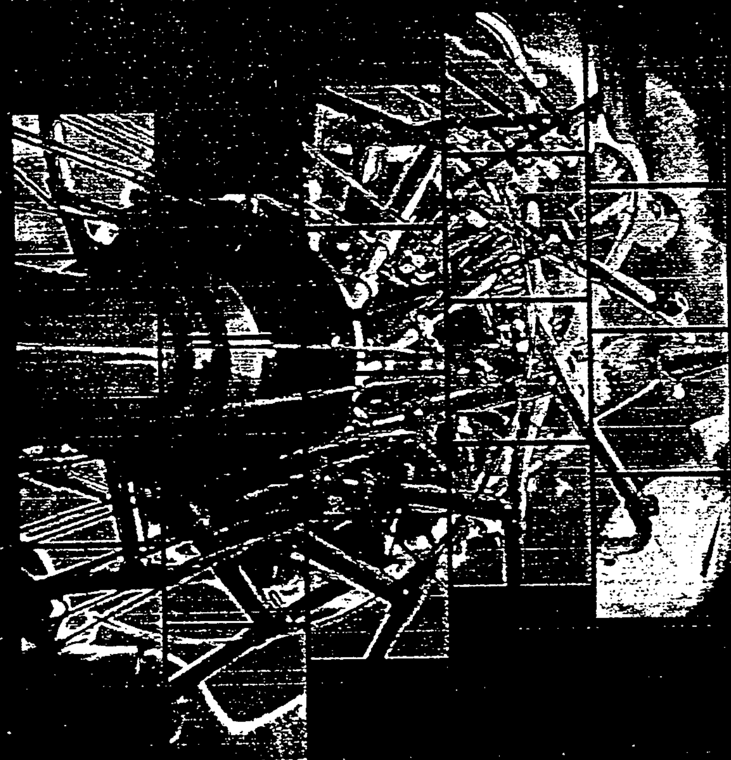
CI-100 &
power pack = $100.00
Installation = $60.00
Total Cost = $160.00
Payback = 6.2 Months
ROI = 193%

039JC2

**Sensor, power pack, and installation costs are approximate.

University of Wisconsin–Madison/Extension

Mechanical Engineering and Energy Course Schedule



January–June 1995

Department of Engineering Professional Development
College of Engineering

For More Information or To Enroll

To request brochures for particular courses or to enroll, complete the attached postpaid card and mail it.

Or fax it toll free to 800-442-4214 or 608-265-3448.

Or call toll free 800-462-0876 or 608-262-2061.

General Information

Fees Course fees generally cover a prepared set of notes, lunches, and refreshments, and may include a dinner, a text or special equipment use. Fees and course dates listed herein are subject to change. Fee discounts are often available when two or more people from the same organization attend a course.

Pre-payment Not Required Enroll now, and we'll bill you later. Or send a purchase order or check, payable to UW–Madison, to the Wisconsin Center, 702 Langdon Street, Madison, WI 53706. We also accept MasterCard, VISA and American Express.

Location Unless otherwise specified, our courses are conducted at complete conference facilities in Madison, Wisconsin.

Accommodations Your enrollment confirmation will include hotel/motel information. Advise us at the time of enrollment if you are a person with a disability and desire special accommodations. Requests will be kept confidential.

Save on Air Travel Your enrollment confirmation will include details on discounted airfares.

Continuing Education Units Upon successful completion of our continuing education courses you will earn a specified number of Continuing Education Units (CEU). Some courses listed in this brochure earn university credits.

Professional Development Degree This is an alternative advanced degree for practicing engineers. The courses described in this brochure can apply as credit toward this University of Wisconsin Professional Development degree. Call for details and qualifications.

Distance Education Because it is often more convenient for you, we offer several ways for you to take our courses at home or at work. See pages 12-15 for details.

For Course Schedules in Other Engineering Areas Call Us!

Course schedules are available in these areas:

Building Design and Construction
Civil and Environmental Engineering
Electrical Engineering, Electronics and Telecommunications
Manufacturing and Product and Process Engineering

Industrial Energy Systems (EM4)

May 1–5, 1995 5208D

Successful industrial energy managers have cut energy indices by 25 percent or more. This course will provide methods to help you develop an appropriate energy index for measuring performance and controlling energy costs. You will review the basics of process energy analysis and compare theoretical, potential, and actual performance of industrial energy systems. Your learning will include the latest heat recovery technology, combustion equipment, adjustable speed drives and digital process controls. Plan to work with other energy managers in solving typical industrial energy problems. Topics for this course include:

- energy management performance analysis and forecasting
- process energy analysis techniques
- energy efficiencies of commonly used systems
- optimization of operation and control
- cost-effective retrofits
- latest technology for waste heat utilization
- energy-efficient designs, systems and components for replacement and new construction
- methods for analyzing potential savings.

Fee: $1145 Director: Keith Kempski

Building Energy Systems (EM3)

July 17–21, 1995 5238D

Developing Effective Energy/Environmental Programs (EM1)

September 11–15, 1995 5773D

HVAC Systems for Buildings

Piping Systems for HVAC

February 20–24, 1995 5015D

This course will develop your understanding of fluid systems encountered in air conditioning of buildings, and specifically of piping systems for water, steam, and refrigerants. Emphasis will be on understanding the factors that influence pipe sizing, balancing, and pump selection to meet the air-conditioning system needs.

Fee: $1095 Director: Harold Olsen

Direct Digital Controls for HVAC

February 27–March 3, 1995 5023D
in Las Vegas, Nevada

June 19–23, 1995 5028D
in Madison, Wisconsin

This course introduces you to the design and application of direct digital controls (DDC) for commercial and industrial HVAC systems. The course begins with a thorough discussion of the capabilities of system architecture and communication concepts, programming concepts, and performance of peripherals. The course then proceeds to apply DDC to the requirements of air conditioning equipment and distribution systems from packaged rooftop single zone to built-up dual fan VAV systems. Point selection and economic analysis are key points of discussion. The different programming concepts available today (line programming, menu or block programming, and graphical programming) will be discussed and demonstrated. The course concludes with a detailed presentation on the acquisition process, including plans, specifications, and project management. Sample specs and drawings are part of the course material.

Fee: $1145 Director: Charles Dorgan

Energy Management

Professionals in the energy field can participate in the Energy Management Diploma Program, which focuses on developing management abilities and establishing a workable energy management organization. Each course provides comprehensive coverage of a specific aspect of energy management. You can attend any one course or all, in a sequence convenient to you. Qualified individuals who complete all four courses and an exam may earn an energy management diploma.

"This course exemplifies what I expect from your courses: technically proficient speakers who also provide enjoyable presentations."

Gerald Menefee
Director of Community Services
City of Gladstone, Missouri

For more information or to enroll, please call 800-462-0876.

Successful Energy Project Analysis and Selection (EM2)

March 6–10, 1995 5235D

To identify, evaluate or select effective energy conservation measures, you must understand where and how energy is used in your facility. You must analyze utility bills and rate schedules for opportunities to reduce costs. Finally, you must understand your company's investment criteria to ensure that recommended projects are funded. This course will help you develop an organized approach to energy data gathering and analysis in your facility. You will learn how to use key energy management tools—from a thorough and efficient walk-through energy audit to the latest microprocessor-based electronic data collection techniques. You will look at sources of energy use information—in-house technical personnel, consultants, and utility companies—studying the strengths and weaknesses of each and determining the best source of information for your facility. Help ensure good energy calculations and economic analyses by studying:

- what to include in effective energy audit reports
- what auditor experience is necessary
- how to use utility DSM programs
- what procedures and calculations to use
- useful instruments and measurements
- how to analyze utility rates and schedules
- how to calculate energy savings and benefits.

Fee: $1145 Director: Keith Kempski

Energy Auditing/ Analysis

These courses are part of a series that will help you to focus your technical experience on the skills required for auditing or analysis, rather than designing, various building and energy systems. Our auditing courses combine a mix of classroom lectures and on-site fieldwork. You gain both the theoretical background and the practical experience for understanding energy systems found in all types of buildings.

HVAC Systems and Controls

February 6–10, 1995 **5234D**

Improvements in HVAC systems and controls are unique because simple or complex changes often result in approximately the same level of performance improvement. Yet, investment costs and paybacks will vary substantially. This course will help you to understand your options and make the best decisions. You will analyze systems, evaluate performance and recommend improvements for comfort and energy conservation. Plan to study these topics and more:

- HVAC system characteristics
- psychrometrics and control of HVAC processes
- air distribution, comfort and indoor air quality
- successful variable air volume retrofit strategies
- temperature controls, energy management and direct digital controls.

The course will build upon material presented in our course, *Fundamentals of Energy Auditing*.

Fee: $1095 Director: Keith Kempski

Fundamentals of Energy Auditing

April 24–28, 1995 **4670D**

Auditing of commercial buildings demands skills different from those used with residential structures. This course teaches you a proven approach to doing energy audits. You will review basic systems—HVAC, plumbing, electrical, and building envelope—as they apply to small commercial buildings. Principal topics will include:

- building energy use fundamentals
- energy estimating methods
- HVAC and lighting system basics
- effective data collection and analysis techniques.

Fee: $995 Director: Don Schramm

Commercial/Industrial Energy Analysis

August 14–18, 1995 **5239D**

Subjects were covered well. I appreciated the ample opportunity to practice hands-on the subject material.

Jeffrey S. Nettesheim
Utility Engineer
Village of Germantown, Wisconsin

Mechanical Engineering and Energy Courses

Central Utility Plants

Improving Cooling Tower Operation and Cooling Water Treatment

January 4–6, 1995 5644D

Systems engineering and water treatment considerations for modern water cooling facility operations will be the emphasis for this intensive three-day course. You will study in-depth the causes and correction of water-related cooling system problems.
Fee: $795 Director: Jack Quigley

Boiler Plant Operation and Orientation

January 9–11, 1995 5645D

Increase your basic understanding of boiler plant operation and of boiler plant auxiliaries such as turbine systems.
Fee: $795 Director: Jack Quigley

"Of all the seminars I've taken over the years, this was by far the best because the topic was thoroughly covered—not the usual superficial treatment."

Richard Yancey
Quality Assurance Consultant
I/N TEK
New Carlisle, Indiana

For more information or to enroll, please call 800-462-0876.

Cogeneration Technology

March 13–17, 1995 5016D

During the last 10 years, significant improvements in cogeneration equipment and cogeneration systems have been made. Today both large and small energy users can benefit from a cogeneration system. Given the increase in electrical demand, cogeneration can produce an economic payback of six months to two years for peak shaving or supplementary power. Longer term paybacks are possible for locations that need large reliable energy sources. This course focuses on concept design and preliminary equipment selection to aid you in decision making and rough plant layout. During the group design sessions you will make individual and group judgments, calculations, and decisions for a given application. Computer software for preliminary analysis will be provided.
Fee: $1295 Director: Harold Olsen

Basic Boiler Water Treatment

May 8–10, 1995 5646D

This course provides a basic understanding of low- to medium-pressure boilers for heating or process operations, and steam-generating systems and their components and operating problems. You'll gain a working knowledge of the methods available to protect this costly capital equipment from premature failure or damage by scaling, corrosion, and carryover.
Fee: $795 Director: Jack Quigley

Boiler Plant Optimization: Basic Concepts and Applications

June 5–8, 1995 5778D

This practical course presents the fundamental aspects of conventional fuel combustion, with emphasis on how these influence boiler plant operations.
Fee: $895 Director: Jack Quigley

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